VOLUME XVIII AUGUST, 1927 SEP 13 1927 NUMBER 2

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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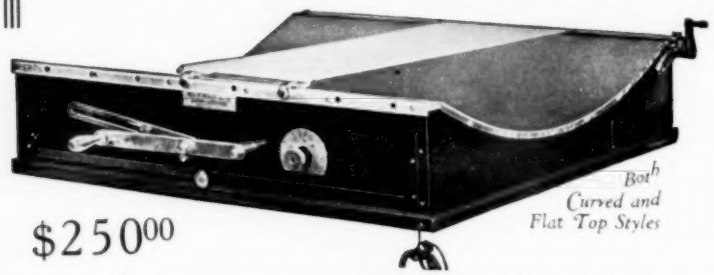

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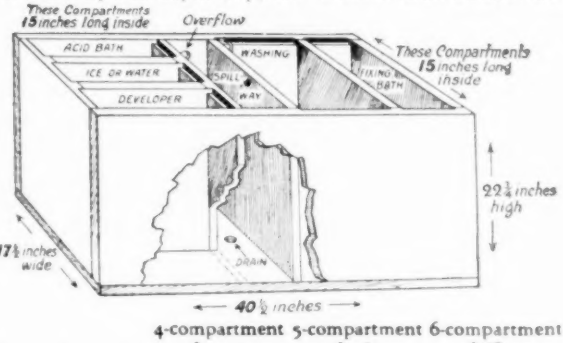

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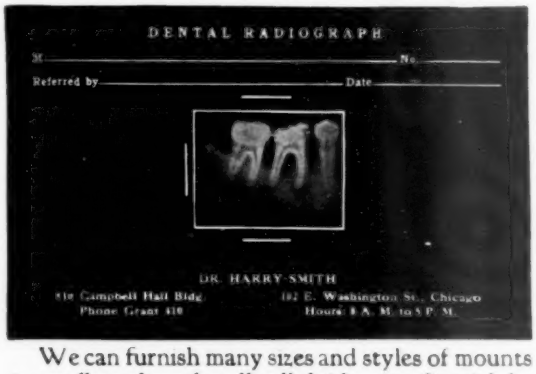

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XVIII AUGUST, 1927 No. 2

SOME EFFECTS OF ROENTGEN IRRADIATION OF THE HEART IN RHEUMATIC CARDITIS*

BY ROBERT L. LEVY, M.D., AND ROSS GOLDEN, M.D.

NEW YORK CITY

IN the course of rheumatic fever, cardiac involvement is frequent and constitutes the chief menace of the disease. No method is known whereby affection of the heart may be effectually prevented, nor has it been possible significantly to modify the progressive character of the lesions initiated in the structures of the heart by the rheumatic process. Rheumatic lesions are of two kinds: (1) exudative, exemplified by effusions into the joints and serous cavities, and (2) proliferative, appearing characteristically in the myocardium as Aschoff bodies and in the valves as vegetations and scar tissue.[1]

There are reasons for believing that roentgen rays, in suitable doses, might be expected to exercise an effect upon rheumatic lesions in the heart. Radiotherapy has been successfully employed in the treatment of certain low-grade infections and is now standard practice in the management of tuberculous lymphadenitis and acne. Even more acute inflammatory conditions, such as carbuncles, furuncles and erysipelas, are often favorably influenced. The result of the treatment appears to be an increase in the local resistance to the invading organisms, but the mechanism by which this is brought about is not understood.

Another well-known effect of roentgen therapy is its action upon scar tissue. Cicatrices of the skin become softer and more flexible after irradiation, and keloids may be greatly reduced in size. Hence, the possibility was considered that the physical condition of thickened, stiff valve leaflets might be altered. The dose necessary to modify cicatricial tissue, however, is greater than that used in the treatment of infections and the time required for the change to appear is much longer. It is probable that this effect played no rôle in the results now reported. It is a problem which we propose to investigate.

In presenting this report, it is realized that the number of cases is small and the period of observation relatively short. The findings are described without any attempt at their interpretation at this time.

LITERATURE CONCERNING THE EFFECTS OF ROENTGEN IRRADIATION ON THE CARDIOVASCULAR SYSTEM

Clinical. Beeck and Hirsch,[2] practitioners of Berlin, were the first to employ roentgen-ray therapy in disorders of the circulatory system. In 1916, they reported 10 cases with organic cardiovascular disease, which received irradiation over the region of the heart and aorta. Twelve treatments were given to each patient. Six were given weekly, to be followed, after

* From the Department of Medicine, College of Physicians and Surgeons of Columbia University and the Presbyterian Hospital. Preliminary Report read at the Twenty-Seventh Annual Meeting, AMERICAN ROENTGEN RAY SOCIETY, Detroit, Mich., May 17–21, 1926. See also *Proc. Soc. Exper. Biol. & Med.*, 1926, xxiii, 351–353.

an interval of two or three weeks, by another course of six irradiations, also one week apart. Then a treatment was given every three or four weeks. The subjects were observed over a period of eighteen months.

The chief complaint of these patients was pain, either precordial or substernal. In all, the signs were those of aortitis, with dilatation of the aorta and cardiac enlargement. In 4 cases, the aortitis was due to syphilis, in 6 to arteriosclerosis. In all 10 cases, marked relief from pain was noted, often after various other forms of therapy had proved unavailing. In one patient, teleroentgenograms indicated distinct diminution in the width of the aorta following roentgen therapy. No explanation of these effects is offered.

The technique employed varied. In 5 patients, the factors are not given. In the remaining 5, the smaller type of "Polyphos" apparatus was used. The machine setting is quoted from the original text because of the difficulty of translating the factors into terms now in common use: "Röhrenhärte betrug 26 mm.* parallele Funkenstärke, die Belastung war 1½ ma., Fokushautdistanz 22 mm.,* Filterung mit 3 mm. Aluminium. Bei jeder Sitzung wurden 5 H pro Feld verabreicht, und zwar wurde pro Sitzung nur ein Feld, entweder von der Brust oder vom Rücken, aus bestrahlt."

In 1923, Groedel and Lossen[3] of Bad Nauheim, reported that they were unable to confirm these satisfactory therapeutic effects. They also attempted to relieve pain of cardiac or aortic origin. Twenty cases were followed during a period of three years. Of 5 patients with syphilitic aortitis, 2 gave evidence of slight subjective improvement. Five non-luetic cases of angina were afforded no relief. The other 10 patients had no demonstrable organic cardiovascular disease and were regarded as instances of "angina vasomotoria." Of these, 1 was cured, 4 were improved and 5 were uninfluenced. The authors state that they are unable to conceive of any sound theoretical basis on which improvement might be anticipated. They call attention to the fact that in "vasomotor angina," which, from their account, is to be regarded as a cardiac neurosis, any suggestive therapy may prove helpful.

The technique of Groedel and Lossen was of two sorts: (1) "Apex-Tiefentherapie-Instrumentarium, Duraröhre mit Erdung oder Siederöhre, 2½ bis 3 ma., 9 bis 10 Bauer, 3 mm. Aluminium filter, 23 cm. Fokushautdistanz, breiter Tubus, Einfeldbestrahlung, Zentrierung auf obere Hälfte des Sternums, Sitzung 10 Minuten lang, Resultat 50 bis 100 X unter 10 mm. Aluminium, acht Sitzungen, möglichst aufeinander folgenden Tagen; (2) Symmetrieapparat, selbst hartende Siederöhre, 0.5 mm. Zinkfilter, Einfeldbestrahlung wie oben, eine Sitzung von 35 Minuten, eventuell Wiederhohlung nach drei Wochen."

In the article by Groedel and Lossen, mention is made of a brief report by Stephan (reference not given), who claimed to have cured a case of bacterial endocarditis by irradiating the precordium with 1/10 skin erythema doses of roentgen rays. In the ensuing discussion at the Frankfurter ärztl. Verein, much doubt was cast upon the correctness of the diagnosis.

In 1924, Schweizer[4] examined at necropsy the heart of a woman of thirty-two, who had received intensive irradiation to the mediastinum for Hodgkin's disease. She died sixteen months after the onset of symptoms. The diagnosis appears questionable, inasmuch as a papule excised from the chin four months prior to death was diagnosed under the microscope as a tuberculide.

Roentgenotherapy was given in five courses during a period of fourteen months. The technique was as follows: "Die Bestrahlung wurde in Feldern vorgenommen, pro Feld 2 Sabourauds verabreicht (gemessen unter dem Filter von 8 mm. Aluminium, Fokushautabstand 22, Tubus 12, selbe Röhre, Härte 220–230, Zeit 22–26 Minuten). Pro eine Serie wurden 4 Felder der Brust, 4 Felder des Rückens und je ein Feld in der Achselhöhle bestrahlt. Darnach betrug die Gesamtstrahlenmenge einer Bestrahlungsserie zehnmal 2 Sabourauds. Bei der 3. bis 5. Serie wurde auch der Bauch bestrahlt."

The heart was adjacent to the tumor

*"MM" in the original article should undoubtedly read cm.

and the author believes that the roentgen rays produced direct effects on both structures. The heart was small and soft. Microscopically, the myocardium showed fatty and granular degeneration, such as are commonly observed in various infections and intoxications. Lesions regarded by Schweizer as denoting specific roentgen-ray injury were swelling and destruction of the sarcolemma, breaking down of myoplasm with ejection of myoplastic granules (plasmoptysis), marked nuclear multiplication and a peculiar change of the myoplasm into globules resembling embryonic structures. The specific changes were most marked in the right ventricle.

Emery and Gordon[5] observed 17 cases ranging from ten to sixty-six years of age, receiving irradiation over the chest for Hodgkin's disease, cancer of the lung, leucemia, myeloma, sarcoma of the mediastinum and other conditions for which thoracic roentgen therapy was employed. The effects of the rays on the heart were studied in 9 cases by means of electrocardiograms and the heart was examined at necropsy in 8 instances. The electrocardiograms were negative except in 2 cases. One, receiving a large total dosage (8225 ma-min.) showed slight flattening of the T-wave in all leads. However, no control record was taken. The other case showed nodal beats, auricular premature beats, sino-auricular block, ventricular and interpolated extrasystoles. Again no control electrocardiograms were made but an arrhythmia was noted before treatment was begun. Pathologically, no characteristic changes were seen which could be ascribed to the irradiation.

It was concluded from this study that no damage to the myocardium was produced. The occurrence of temporary changes was not excluded nor was it possible to say that more intensive irradiation was harmless. No signs of circulatory embarrassment ascribable to roentgen-ray injury were observed.

The dosage given was as follows: Target skin distance, 30 cm.; 140 kv. peak, filter, 0.25 mm. copper, 1 mm. aluminum and 1 thickness of sole leather, or, target skin distance, 80 cm., kv. peak constant, 170, filter, 0.5 mm. copper. The total dosage was from 550 to 8225 ma-min. From two to eight treatments were given.

Experimental. In 1924, Gordon, Strong and Emery[6] studied 23 rabbits, of which 16 received direct irradiation over the precordium in single large doses, or repeated small doses at intervals over a period of several months. Seven received irradiation over the abdomen to determine any indirect effect of the rays on the heart. The total exposure varied from 15 minutes to 3 hours and 20 minutes. The single doses varied from 5 minutes to 1 hour and 15 minutes. The animals were followed from 12 hours to 6½ months. The machine setting is not given in detail. Individual treatments ranged from 25 to 375 ma-min., the total dosage from 75 to 1000 ma-min. The area irradiated was 2.5 × 3 cm. Frequent roentgenograms and electrocardiograms showed no changes except for one rabbit, in which ventricular extrasystoles were recorded after 2 hours and 5 minutes of irradiation given in 15 minute doses once a week. The cardiac irregularity disappeared after treatment was stopped.

Pathologically, no characteristic changes were noted. One rabbit showed a few white spots in the myocardium and in one there were a few clumps of fibrin in the pericardial sac. Microscopically, small areas of necrosis or fatty infiltration were seen in the heart muscle, but these were not unlike the changes described by MacCallum as occurring in the course of various infections, intoxications and nutritional disturbances.

Davis[7] at the Mayo Clinic, irradiated the right lung of rabbits and dogs in an attempt to produce pulmonary fibrosis, the left lung being used as control. Twelve necropsies are reported. The dosage given to the dogs was: 135 kv. peak; 5 ma. 12 cm. target skin distance; 6 mm. aluminium filter; 4 treatments at about 2-week intervals, the individual exposures being 60, 60, 30 and 60 minutes. Alopecia occurred in all of the animals and a burn of the skin in one. The animals were killed seven weeks after the last irradiation. In one dog, at necropsy, the anterior wall of the right auricle showed thickening and petechial hemorrhages. Microscopically, in the mus-

culature of the auricle were seen areas of cell necrosis, extravasation of red blood corpuscles and necrotic muscle fibers fused into hyaline masses. There was also marked proliferation of connective tissue, not only in the necrotic areas but also around the blood vessels and adjacent structures. The microscopic changes in the wall of the right auricle were found in all but 2 dogs and in these the irradiation did not strike the heart.

To summarize the literature just cited, it may be said that roentgen-ray therapy for the relief of cardiac pain has been of doubtful value. Post-mortem examination of the heart of one patient with Hodgkin's disease who received irradiation over the mediastinum, showed myocardial lesions believed to denote specific roentgen-ray injury of the heart muscle. In numerous other cases receiving roentgen therapy over the chest for various forms of thoracic tumor, and examined electrocardiographically and at necropsy, no evidence of cardiac damage was found. In a series of rabbits irradiated over the heart with doses comparable to those employed in the clinic, transitory ventricular premature beats were recorded once. Pathologically, no characteristic changes were noted. Following exposure of the right lung of dogs to considerably larger doses, cell necrosis, hemorrhage and proliferation of connective tissue were found in the musculature of the right auricle.

CASES OBSERVED IN THE PRESENT STUDY

With the idea of attempting to influence the cardiac lesions of rheumatism in a favorable manner, 20 patients with rheumatic carditis were given irradiation to the heart. A detailed clinical analysis will be presented after a larger number of cases has been observed over a longer period of time. In the group are included patients exhibiting various phases of rheumatic infection—acute and chronic; febrile and afebrile; those in the first attack with early cardiac involvement; others with huge hearts and severely damaged valves with advanced mechanical defects; and 2 youths with badly damaged hearts in whom sharp attacks of precordial pain were the dominant feature. The material was deliberately unselected, the purpose being to ascertain, if possible, which types of rheumatic carditis might be influenced by roentgen rays. In addition to noting changes in clinical condition, frequent electrocardiograms and numerous teleroentgenograms were made.

TECHNIQUE OF IRRADIATION

The quantity of rays used to influence infections is ordinarily relatively small. This fact, together with a desire to avoid any possibility of injury to the heart, made it seem advisable to use small doses. The treatment was given at first with the idea of modifying the reaction of the tissues of the mitral area. The machine setting was: 200 kv. (peak); 50 cm. target skin distance; 0.5 mm. copper plus 1.0 mm. aluminum filter. The chest was measured and with the help of a depth-dose chart, a quantity of rays was applied calculated to yield about 10 per cent of the erythema dose in the region of the mitral valve. The treatment was repeated every two weeks until four had been given. An interval of time varying from one to several months was allowed to elapse and the series was then repeated.

As evidence accumulated tending to show that the myocardium was being affected, it seemed advisable to distribute the rays as evenly as possible throughout the entire cardiac area. With the aid of a cross-section diagram of the chest at the level of the fourth chondrosternal junction and a depth-dose chart, it became our custom to give through a field, both front and back, a quantity of rays calculated to yield about 10 per cent of the erythema dose throughout the region of the heart. The fields were large enough to include the entire cardiac area and were centered 4 to 5 cm. to the left of the midline. They did not include more than the necessary area because of the desirability of avoiding "roentgen sickness." The usual dose was 36 ma-min. over the front and from 54 to 72 ma-min. over the back, depending upon the size of the chest. If nausea and vomiting occurred, subsequent doses were decreased to 8 per cent of the calculated erythema dose.

Whether this technique requires modi-

fication, it is not possible to say at the present time. Perhaps the irradiation should be repeated once a week instead of once in two weeks. It may be found desirable to employ a larger dose and a longer interval of time, or a smaller dose and a shorter interval. More extensive experience should furnish an answer to these questions.

EFFECTS OBSERVED

These are summarized in Table 1 and will be described in greater detail in a subsequent communication.

TABLE 1

SUMMARY

20 Cases.
139 Irradiations (18 cases received 4 or more).
388 Electrocardiograms.

Duration of Follow-up Since First Irradiation

18 months	2 cases
16 months	1 case
6–10 months	13 cases
3–5 months	4 cases.

Electrocardiographic Changes

Present	14 cases
Absent	6 cases.

Clinical Condition at End of Follow-up Period

Improved	17 cases	
Unimproved	1 case	
Dead	2 cases	(after 6 and 10 months, respectively).

Relationship of Electrocardiographic Changes to Clinical Condition

Improvement with EKG changes	12 cases	
Improvement without EKG changes	5 cases	
EKG changes without improvement	2 cases	(both dead)
No improvement or EKG changes.	1 case	(had only 2 irradiations).

(1) *Changes in the Electrocardigoram.* In normal individuals, the form of the electrocardiogram remains quite constant over relatively long periods of time. As a result of disease of the heart, changes may occur. Alterations in form are also observed after the administration of certain drugs, such as digitalis, or in the course of systemic disorders which alter the state of the myocardium. In rheumatic fever, electrocardiographic evidence of myocardial involvement is frequently obtainable, as has been particularly emphasized by Cohn and Swift.[8] The changes observed in this disease are chiefly of three sorts; (*a*) change in the duration of auriculoventricular conduction time; (*b*) alteration in the ventricular complex, affecting the initial (QRS) portion, the R-T interval or the T-wave, and (*c*) the occurrence of irregularities in cardiac rhythm. These changes are not to be regarded as specific; they are merely an expression of disturbance in the heart muscle.

The changes in the form of the electrocardiogram observed after roentgen irradiation of the heart have been of the same general order as those just enumerated. That this should be so, was to be anticipated, provided changes occurred at all. For, though evidence is as yet wanting, it may be supposed that the rays induced an altered reaction of the tissues of the heart with modification of the rheumatic lesions in the myocardium. The fact that changes in the form of the graphs did not occur in every instance, lends support to the concept; for myocardial lesions are not found in every case of rheumatic heart disease. It seems probable also that the lesions vary in their susceptibility to the effects of irradiation at different stages of their evolution. With the nature of the reaction, we are not, for the moment, concerned.

Changes in the form of the electrocardiogram were observed in 14 of the 20 cases receiving irradiation (Table 1). Inasmuch as adequate control records were made before exposing the heart to the rays, it is believed that these alterations were due to the effects of irradiation on the heart. Care was exercised not to confuse these findings with changes due to digitalis. Salicylates, in our experience, do not modify the electrocardiogram. The changes were as follows:

(*a*) Inversion or deepening of the T-wave—6 cases. This was seen sometimes in all leads, occasionally only in Lead III. In the patient whose curves are reproduced in Figure 1, inversion of the T-wave in Lead III was observed in association with three courses of irradiation, the wave returning to its original upright position during the interval between courses.

(*b*) Notching or inversion of the P-wave —5 cases (see Fig. 2).

(*c*) Change in the form of QRS—5 cases.

(*d*) Shortening of auriculoventricular conduction time—1 case. This was a transitory effect.

(*e*) Appearance of right ventricular preponderance (change in electrical axis) —6 cases. This always followed soon after exposure and was of short duration.

(*f*) Occurrence of irregularities of rhythm. These were transitory. Ventricular premature beats were recorded in 3 instances, auricular premature beats twice.

The time of appearance and duration of the changes in relation to irradiation were variable. The T-wave inversion usually developed gradually and lasted for weeks or months. The other changes appeared soon after exposure and were evanescent, disappearing often in the course of a few days.

(2) *Effect on the Size of the Heart.* No changes were observed in the teleroentgenograms which could be related to roentgen irradiation.

(3) *Effect on Clinical Condition.* It is not our purpose at this time to discuss the value of roentgen irradiation of the heart as a therapeutic measure in rheumatic heart disease. Obviously, both material and time of observation are inadequate. The facts are summarized in Table 1.

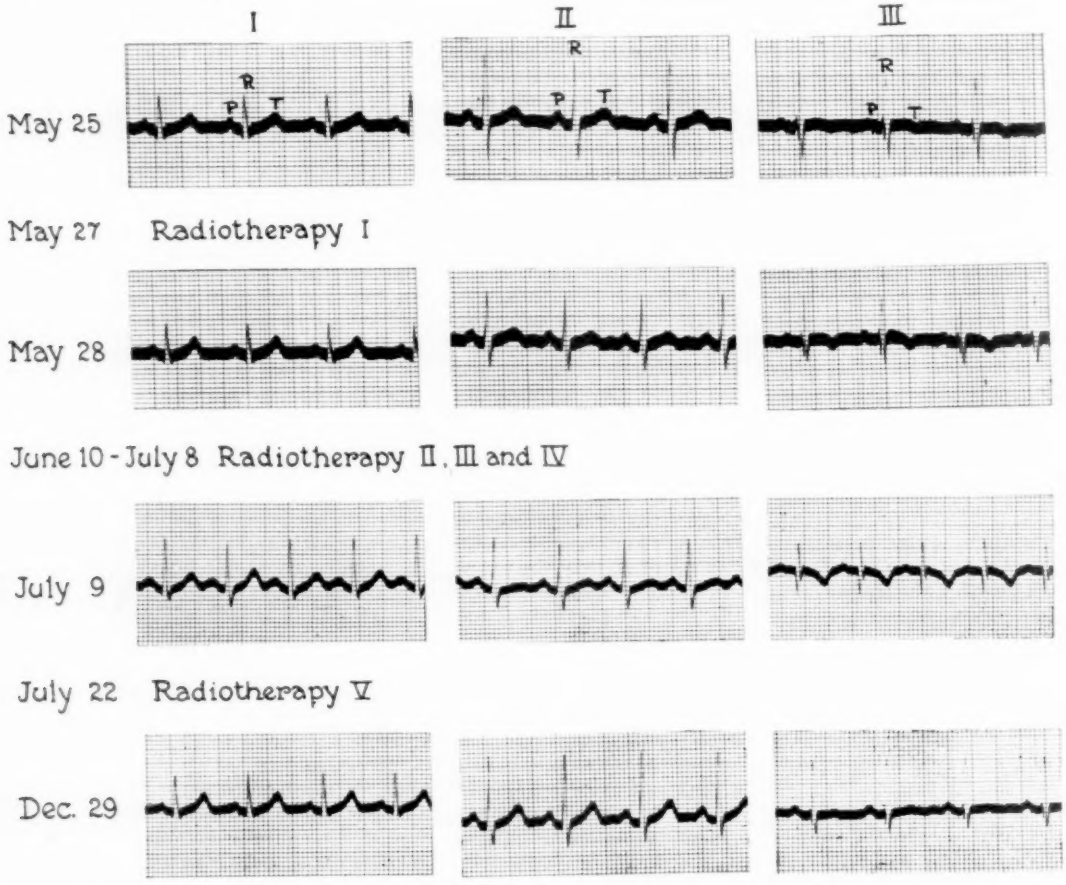

FIG. 1. Effect of irradiation on the T-wave of the electrocardiogram. The record of May 25 serves as control. In the records of May 28 and July 9, the T-wave in Lead II has become flattened, and in Lead III, progressively inverted. From July 22 to Dec. 29, no roentgen therapy was given. The record taken on the latter date shows a return of the T-waves to the forms observed in the control.

Of the 20 cases, 17 showed definite improvement, as indicated by cessation of fever, fall in heart rate, disappearance of leucocytosis and gain in weight. Salicylates and drugs of the cinchophen group were used freely, though always discontinued for a reasonable period before the patient was discharged from the hospital. In only 12 of these 17 cases were changes

noted in the electrocardiogram. One exceptionally satisfactory result may be briefly mentioned. In a girl of thirteen, with large heart and mitral disease, all the usual therapeutic procedures, including several transfusions, were unavailing during a nine months' hospital stay. Fever and tachycardia continued, although there were negligible joint manifestations. Five improvement seemed definite. One patient was unimproved after two exposures; the myocardium was too severely damaged to justify continuation of irradiation. Two boys are dead. Both had extensive mechanical defects, with progressively active lesions and paroxysms of precordial pain. Permission for necropsy was not obtained in either case.

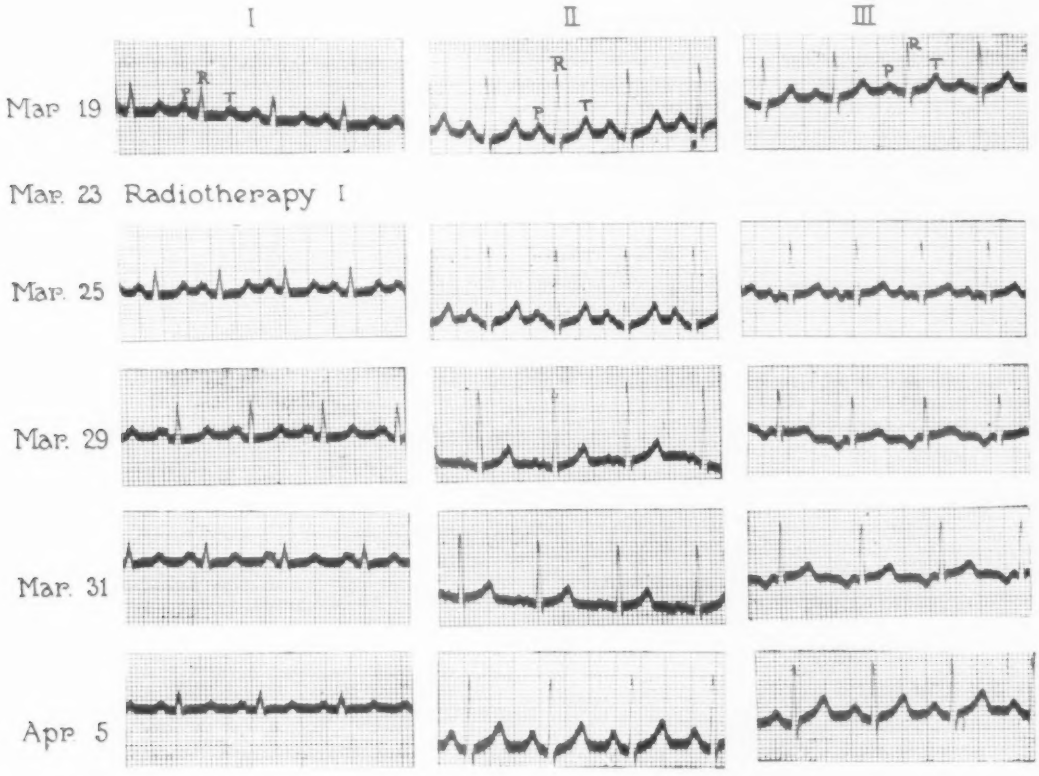

Fig. 2. Effect of irradiation on the P-wave of the electrocardiogram. The record of March 19 serves as control. Two days after the first roentgen therapy, the P-wave in Lead II is flattened and more markedly notched. In Lead III, it has become diphasic. In the two subsequent records, the changes are accentuated, the P-wave in Lead III being sharply inverted. On April 5, two weeks after roentgen therapy, the P-waves have returned to the forms observed in the control.

days after the first irradiation, the temperature fell to normal, with parallel decrease in heart rate. With but few minor setbacks, improvement continued, so that after eighteen months the child has gained considerable weight and is at school. During this eighteen month period she received twelve roentgen exposures in three courses. The relationship of roentgen irradiation to the initiation of clinical

UNTOWARD EFFECTS

In no instance was there any evidence that the heart was injured or the course of the disease unfavorably influenced. A number of the patients complained bitterly of the disagreeable odor of the room during the period of exposure. Eight patients reported the following symptoms: general malaise, twice; headache, twice; anorexia, once; nausea, four times; vomiting five

times; increased chest pain, twice. On two occasions there was transitory exacerbation of fever. The symptoms usually lasted from twenty-four to forty-eight hours. Two patients stated that malaise and anorexia persisted "for almost a week." They were, however, willing to return for further irradiation.

It is not clear why these 8 individuals should have suffered temporary discomfort. The symptoms appeared at irregular intervals, were apparently not related to the severity of the cardiac condition and were observed more frequently after the later rather than the initial exposures. The other 12 patients were quite undisturbed.

RESULTS IN SUBACUTE BACTERIAL ENDOCARDITIS

A limited number of irradiations (four and five respectively) were given to 2 patients with *Streptococcus viridans* endocarditis, without effect either on the electrocardiogram or the course of the disease. Both patients are dead.

SUMMARY

1. With the idea of attempting to influence rheumatic lesions in the myocardium, 20 patients with rheumatic carditis were given 139 irradiations to the heart. The machine setting was calculated to yield 1 10 of the erythema dose distributed throughout the heart muscle. Frequent electrocardiograms and numerous teleroentgenograms were made.

2. Changes in the form of the electrocardiogram were observed in 14 of the 20 cases. The changes were similar to those sometimes found in the course of rheumatic fever and regarded as due to myocardial involvement. It is suggested that the alterations noted following roentgen irradiation of the heart occurred as a result of the action of the rays on the tissues of the heart with modification of the rheumatic lesions.

3. No changes were observed in the teleroentgenograms which could be ascribed to roentgen irradiation.

4. Of the 20 cases, 17 showed definite improvement. The value of roentgen irradiation of the heart as a therapeutic measure in rheumatic carditis is not stressed on the basis of these observations, because of the small number of cases studied and the relatively short period of follow up. A detailed clinical study will be reported at another time.

5. In 8 patients, mildly unpleasant symptoms were noted. In no instance was there evidence of cardiac injury or unfavorable effect on the course of the disease.

6. In 2 cases of *Streptococcus viridans* endocarditis, roentgen irradiation of the heart caused no change in the form of the electrocardiogram nor did it modify the fatal progress of the disease.

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II. HISTOLOGICAL CHANGES IN THE SINO-AURICULAR NODE AND ADJACENT TISSUES OF THE DOG FOLLOWING RADIUM EMANATION*†

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THE cardiac impulse in mammalia is believed to be initiated normally in the sino-auricular node, a bit of tissue probably represented embryologically by the sinus venosus, lying at the junction of the superior vena cava and the right auricle. The exact method of transmission of the impulse to the auriculo-ventricular node, though uncertain, is thought to be through the ordinary auricular muscle fibers. From the auriculo-ventricular node, the impulse travels through the branches of the bundle of His to the Purkinje cells lying beneath the mural endocardium. Thus the impulse is brought into contact with all parts of the ventricular musculature.

This study comprises the histological changes observed in the sino-auricular node and adjacent cardiac tissue following the direct application of radium emanation rays. The author is unaware of any previous study of the effects of radium emanation upon the structures which initiate and conduct the cardiac impulse. Because of the type of reaction produced, it was first thought that such a study might add information concerning the intimate structure of the sino-auricular node, which is believed to be a muscular tissue. Furthermore, it was believed that a specificity of action by the radium upon the nodal tissue might be observed, the node possibly being more primitive than the surrounding tissue. The view is also held by some that the node is more highly specialized than the surrounding tissue.

Certain anatomical terms as used in this paper have been defined by Gray:

"The separation of the appendix from the sinus venosus is indicated externally by a groove, the *sulcus terminalis* (His), which extends from the front of the superior vena cava to the front of the inferior vena cava, and represents the line of union of the sinus venosus of the embryo with the primitive auricle. In the cavity of the auricle the separation is marked by a vertical, smooth, muscular ridge on the anterior wall, the *crista terminalis* (His.)"[1]

The physiological reaction of the node, following the application of radium emanation rays, will be reported in a subsequent paper.

Sweet[2] has stated in a study of the effect of radium upon normal nerve tissue that the tissues of young animals are more susceptible to radiation than are cells of the same tissue in older animals, and that in the adult body the younger cells are more susceptible than the older cells. Is it possible, the sino-auricular node being more primitive than the surrounding structures, that the radium might act differently upon the two types of tissue?

Pendergrass et al[3] consider that radium acting upon the nucleus and cytoplasm of the cell causes death of the cell under conditions favoring autolysis, the direction of which is determined by the chief component of the irradiated cell. If protein, the toxic products of proteolysis exhibit their general effect. If lipoidal compounds, the toxic components of lecithin produce their characteristic reactions.

Levin and Levine[4] have noted that the action of radium emanation on plant and human tissue is quite analogous. They observed complete necrosis of the first zone of tissue, cellular degeneration in the outer zone, and ultimate absorption of the necrotic area with formation of connective tissue.

Concerning the effect of radium upon blood vessels, it has been noted[5] that the soft beta and gamma rays cause disappearance of capillaries and a fibrinoid necrosis of larger vessels with thrombosis in the vicinity of the radioactive focus.

Gabriel[6] observed the effects of radium emanation upon kidney blood vessels in

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† Preliminary report read by Dr. E. B. Krumbhaar at The Federation of American Societies for Experimental Biology, Cleveland, Ohio, Dec. 30, 1925.

cats, dogs, and rabbits, with a capillary microscope. A dilatation of the afferent vessels was first noted. Later, the glomeruli were distended, followed by hemorrhage into Bowman's capsule. Later still, the glomeruli were shrunken, or in most cases the cells in the wall were destroyed. The epithelium of the tubules was more or less broken up, not by primary necrosis, but by necrobiotic and degenerative processes, especially fatty degeneration. The connective tissue underwent proliferation proceeding from Bowman's capsule and adventitious tissue. Strong doses of radium emanation produced contraction of the vessels. Small doses produced dilatation of the vessels.

METHOD

Under aseptic precautions, the sino-auricular node was exposed in 14 dogs. With air-ether intermittent intratracheal insufflation, using an Erlanger respiratory tank, 4 cm. of the right third or fourth rib was resected, disarticulating at the costo-chondral junction. The pleura was incised and the pericardium exposed. The pericardial sac was opened, and its margins sewed temporarily to the edges of the wound. A suture through the fat in the auriculo-ventricular groove, passing out through the chest anteriorly, rotated the heart on its longitudinal axis, exposing the junction of the superior vena cava and the right auricle. A small glass tube containing radium emanation the strength varying from 0.6 mc. to 5.0 mc. enclosed within a second, larger glass tube 1 mm. in diameter and 10 mm. long, was inserted subepicardially over the sino-auricular node where it was left until recovered at autopsy. During insertion, the tube was held by a blunt tissue forceps, and pushed beneath the epicardium through an initial opening made with the point of a curved needle. The animals were allowed to recover, and were autopsied at periods varying from eight hours to eight months after insertion of the radium. The cavo-auricular junction was fixed in 10 per cent. formalin while fresh, and mounted in paraffin. Serial sections of 10 micra thickness were cut transversely to the long axis of the linea terminalis. Some were stained with hematoxylin and eosin, and others with Van Gieson's stain, using hematoxylin to bring out the nuclear structure.

DATA AND DISCUSSION

The first two experiments are reported in considerable detail to illustrate the method used, and to show the histological differences between the long and short exposure. Table 1 contains a summary of the data and findings in each experiment.

Dog 1. Died ten days after introducing a tube containing 2.0 mc. of radium emanation. Autopsy showed a fibrinous pleurisy and pericarditis. At the region of the sino-auricular node the radium tube was just visible caudally, as shown in Figure 1, drawn twenty-four hours after formalin fixation. It was surrounded by a grayish colored area for a distance of about 2.0 mm. in each direction, outside of which appeared to be an area of hemorrhage.

Histological examination of the above tissue revealed the following: As the superior vena cava and the right auricle gradually merged into one, loose areolar tissue appeared to identify the point of junction. This gradually disappeared as examination of the cross sections continued in a caudal direction. A large vessel was noted in the substance of the superior vena cava, 1.25 mm. above the junction, which gradually approached the epicardial surface as the more caudal sections were examined. This vessel continued caudally for a distance of about 1.5 cm. Several other vessels gradually appeared about the line of the cavo-auricular junction. At a point 6.0 mm. caudal to the junction, the sino-auricular node appeared. It lay beneath the sulcus terminalis contiguous to the superior vena cava. A large vessel lay on its auricular border. The head of the node was about one-half the width it ultimately assumed, 1.25 mm. from the cephalic limit. Figure 2 was drawn to illustrate the relationship between the structures at this point.

The nodal structure was typical and stained differentially with the Van Gieson-hematoxylin stains. Control staining of known nodal tissue was used to secure the best results. It was possible to get the node to take a light tan stain, while the surrounding muscle fibers stained a golden yellow. The nuclei were numerous. The fibers were closely interlaced presenting a homogeneous appearance.

The dosage in this animal was approximately 666 mc-hr. It should be noted that tissue 2.0 cm. removed from the tube received the same duration of exposure but much less concentra-

TABLE 1
ANALYSIS OF RESULTS

Dog	Strength of Tube in Mc.	Survival	Autopsy Findings	Tube Located	Remarks
1	2.0	10 days	Fibrinous pleurisy and pericarditis	Tail of node	Vascular engorgement, hemorrhage, necrosis, fatty change, and scarring.
2	2.0	180 days	Fibrous adherent pleurisy and pericarditis	Body and tail of node	As in No. 1 with advanced scarring, hyalinization, calcification, and thrombosis.
3	1.38	3 days	Empyema	Auricular border of node	Fatty degeneration of node, with endothelial proliferation.
4	0.6	8 hrs.	Operative death	Middle of crista terminalis	Necrosis and pigmentation.
5	1.3	49 days	No noteworthy changes	Not found	No nodal tissue found.
6	Control	3 days	Pneumonia and empyema	At junction below linea terminalis	Hemorrhage, with subsequent fatty change, necrosis and early scarring.
7	0.98	90 days	No noteworthy changes	In tail of node	Fatty change, necrosis and scarring.
8	1.45	5 days	Empyema	Not found	Hemorrhage, necrosis, fragmentation, pigmentation, round cell infiltration.
9	1.0	36 days	Acute glomerular nephritis, stitch abscess and chronic fibrous pericarditis	Tail of node	Hemorrhage, fatty change, necrosis, scarring, endarteritis obliterans of nodal vessels.
10	2.0	240 days	No noteworthy changes	Not found	Hemorrhage, fatty change, scarring, hyalinization, thrombosis, fibrous epicarditis.
11	3.4	210 days	Adherent fibrous pleurisy and pericarditis	Caval side of nutrient vessel and crista terminalis	Hemorrhage, fatty change, necrosis, scarring, hyalinization.
12	1.85	210 days	No noteworthy change	Not found	No evidence of any change.
13	Control	210 days	No noteworthy change	Not found	Slight fatty change with fragmentation at tail of node.
14	5.0	7 days	Pneumonia	Tail of node	Hemorrhage, fatty change, necrosis, and scarring.

tion than the tissue immediately surrounding the tube. The effect expected was noted in this animal at autopsy, as shown in Figure 1, for immediately about the tube, the tissue was light gray in color, surrounding which was an area grossly resembling hemorrhage. The difference in pathological changes, therefore, at varying distances from the radioactive site, is possibly due to decreasing strengths of radiation of equal duration of exposure.

The pathological changes observed in the head of the node and immediately surrounding tissue consisted of an engorgement of the smallest vessels, and a moderate degree of red blood cell infiltration, due possibly to rupture of some of the small vessels. No change was detected either in the nuclei or muscle cells. At a point 0.5 mm. below the cephalic limit of the node, the muscle cells were shrunken, clear, and took a lighter strain. Their nuclei, likewise, were shrunken, clearer, with decreased chromatin content. A photomicrograph (Fig. 3) at this point shows the large nutrient vessel of the node at the lower right corner. Its walls are losing their structure, and there is considerable increase in the areolar tissue surrounding the vessel. The author has never seen a satisfactory untouched photomicrograph of a normal sino-auricular node. While not as clear, photographically, as desirable, Figure 3 shows an area of more nuclei, taking a lighter stain, to the left of the nutrient vessel, which I have blocked off with a penned line, demonstrating nodal tissue. Small punctate areas are discernible, which on microscopic examination were found to be hemorrhage. In the lower central portion, a few large globules of fat are seen.

One millimeter below the cephalic limit of the node, the endocardial half of the band of muscle fibers composing the crista terminalis showed advanced degeneration. There was much débris, disintegration, early necrosis, advanced fatty change, infiltration of numerous endothelial cells, some small round cells, and coagulated areas of hemorrhage. Why this change should have been greater in the endocardial portion of the crista, we are unable to

explain, for the radium tube, as stated below, lay midway between the endocardium and a millimeter further caudally, the damage extended 2.4 mm. in each direction, the

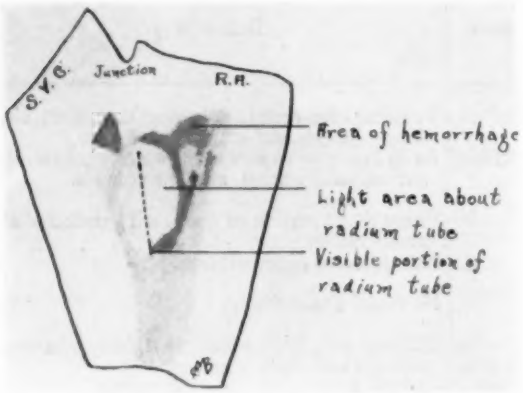

Fig. 1. Cavo-auricular junction of Dog 1 as seen at autopsy showing the junction of the superior vena cava (S.V.C.) and right auricle (R.A.) with the glass radium emanation tube lying practically in the linea terminalis.

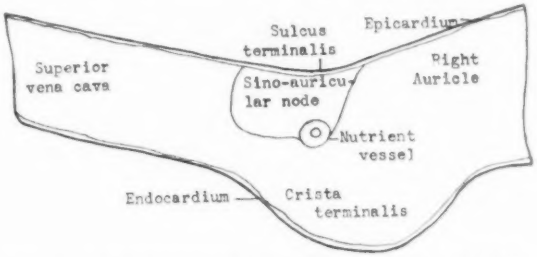

Fig. 2. A diagrammatic drawing showing the relationship of the sino-auricular node to the surrounding structures in Dog 1, 7.25 mm. caudal to the cavo-auricular junction.

extreme auricular portion of the crista being spared. There was considerable deposition of blood pigment with the appearance of new connective tissue. One-half a millimeter still further caudally there were large areas of coagulated hemorrhage.

Fig. 3. A photomicrograph of the sino-auricular node in Dog 1, 0.5 mm. below its cephalic limit. The large nutrient vessel is seen in the lower right corner surrounded by an increase in areolar tissue. The node, which is marked off to the left of the vessel by a penned line, shows an increased number of nuclei and is lighter than the remaining tissue of the crista terminalis seen in the upper left corner. Small punctate areas of hemorrhage marked "h" may be seen in the substance of the node. Stain: Van Gieson and hematoxylin (92×).

epicardium. The damage extended about 1.1 mm. in each direction from the node. One-half

One-half a millimeter further, i.e., 11.0 mm. from the cavo-auricular junction, the tube

hole was first seen. Immediately about the tube there was a complete loss of structure with necrosis. The walls of the central vessel were necrotic, but the lumen contained blood cells and appeared to be functioning without evidence of thrombosis. The changes above described continued caudally for several millimeters. A photomicrograph at this point (Fig. 4) shows the relationship of the tube hole to the nutrient vessel. The hole is on the superior vena cava side of the vessel in the theoretical site of the node. The loss of architecture, a coagulated necrosis, the appearance of new

FIG. 4. Shows the relationship of the tube hole to the nutrient vessel and surrounding tissue in Dog 1. There is complete necrosis of the tissue surrounding the hole with scattered areas of vacuoles. Maturing fibroblasts may be seen above and below the vessel. Stain: Van Gieson and hematoxylin (25×).

connective tissue between the tube hole and the vessel, and scattered areas of vacuoles are distinguishable. The relationship of the size of the tube hole to the width of the tissue suggests the difficulty of introducing a tube 1 mm. in diameter into this tissue, the actual thickness of which was 3.0 mm.

Figure 5, also taken at this point, shows extensive fatty change with development of new connective tissue.

At a distance of 8.75 mm. from the cephalic limit of the node where the damage was observed to extend 6.0 mm. radially about the tube hole, the only structures capable of identification in the large nutrient vessel were the elastica interna and elastica externa, although the vessel lay only 0.3 mm. from the tube hole. Elastic tissue apparently is very resistant to the action of the destructive radium rays. The tube hole finally approached the epicardium and dropped out of the sections 18.2 mm. below the cavo-auricular junction, after it had been observed through a distance of 7.2 mm. These measurements are corroborated by the fact that the radium tube was 1 cm. in length, that approximately 1 mm. of the tube was visible caudally at autopsy, and that the tissues underwent shrinkage during histological preparation.

DOG 2 was in excellent physical condition when killed with ether 180 days after the introduction of a bare tube containing 2.0 mc. of radium emanation. Figure 6 shows the inter-

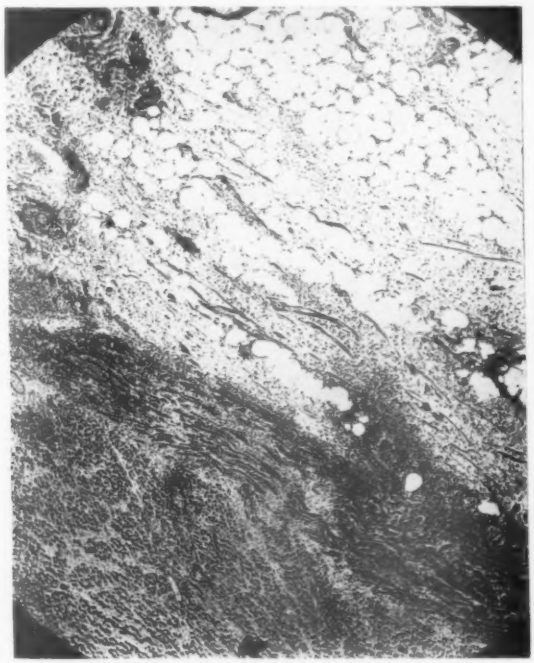

FIG. 5. A photomicrograph of the tissue about the tube hole in Dog 1, showing necrosis, hemorrhage, fatty change, and fibroblasts. Stain: Hematoxylin and eosin (92×).

caval region and part of the right auricle after it had been fixed in formalin for forty-eight hours and the adherent parietal pericardium and visceral pleura had been gently dissected away. A large glass tube is seen passing down through the superior vena cava, the right auricle, and the inferior vena cava, which are labelled S.V.C., R.A., and I.V.C., respectively, About 7.0 mm. below the cavo-auricular junction the cephalic end of the glass radium tube may be seen. It was partly withdrawn from its thin epicardial pocket to render it visible photographically. The area of damage on the epicardial surface is quite widespread extending about 2.0 cm. in each direction.

The tissue within the dotted lines, which

are penned on the photograph, was mounted in paraffin, and serial sections were cut transversely at 10 micra thickness. The following summarizes the findings:

No nodal tissue could be identified in any of the sections, due, no doubt, to the extensive degenerative changes which involved the entire crista terminalis consisting of extensive hemorrhage, fatty degeneration, necrosis, and advanced fibrosis with hyalinization and calcification. There was occlusion of the central nutrient vessel, comparable to that seen in Figure 7. The pathological changes were in the

Fig. 6. Shows the intercaval and cavo-auricular junction in Dog 2 after it had been fixed in formalin for forty-eight hours. A large glass tube is seen passing down through the superior vena cava (S.V.C.), right auricle (R.A.) and inferior vena cava (I.V.C.). The tissue within the dotted lines was the portion sectioned and examined histologically. The cephalic end of the glass radium tube may be seen partially protruding from the thin epicardial pocket. At autopsy, the pericardium and visceral pleura were closely adherent over this entire area, but have been gently dissected away to show the above. (For size, see centimeter scale.)

superior vena cava, crista terminalis, and right auricle, and extended 1.5 mm. above the cavo-auricular junction in the wall of the superior vena cava. Numerous nerve ganglia were observed, but no special stains were used to note any change in these structures. The epicardium and pericardium were much thickened, fibrosed and hyalinized. The essential changes observed were scar formation with hyalinization and calcification.

DISCUSSION

Although it is admitted that interesting results would no doubt have been obtained had an attempt been made to observe the effects of radium emanation upon the node and surrounding tissues at much shorter periods of time after the introduction of the radium tubes than in the method used, it will be seen by the above protocols that in general the type of reaction invoked was the same in the nodal as in the surrounding tissues. However, it was observed that the node seemed to show a greater sensitivity than the surrounding tissues as evidenced by the greater severity of damage when subjected to the same or even less radiation than the surrounding

Fig. 7. Shows the wall of the superior vena cava close to the cavo-auricular junction in Dog. 10. The pericardium on the upper surface has been torn loose and there is hemorrhage on its surface. A large vessel may be seen in the middle occluded by a thrombus in which canalization may be seen. To the right of the vessel, the tissue shows fatty change and necrosis. Stain: Hematoxylin and eosin (25×).

tissue. This might be considered a further verification of the relatively undifferentiated primitive condition of the nodal tissue.

An interesting observation was made in Dog 4. The radium tube was found at autopsy, but was left in place by mistake within the nodal structure for twenty-two days after the tissue had been placed in formalin. The outstanding feature on histological examination was the lack of hemorrhage and of newly developing connective tissue. About 2.0 mm. laterally from the tube hole, which lay in the middle of the crista terminalis, there was scattered considerable dark brown pigment. The

tissues about the tube were necrotic. The cells in the wall of the superior vena cava, 3.0 mm. from the tube hole were distended, their nuclei and cytoplasm pale and shrunken. They gradually merged into the necrotic area about the tube. The changes, therefore, observed in this animal were of the same character as those observed in the other animals, except for the lack of hemorrhage and new connective tissue. It is doubtful that the changes noted were produced in life within eight hours after the introduction of the radium tube. They may have resulted from the radium emanation acting after death of the animal, that is, after the circulation to the part had ceased. This suggests that the changes observed were not nutritional, but due to direct action upon the cells and nuclei. Obersteiner[7] and Bagg, Ewing and Quick,[8] have reported that radium has no specific effect upon nerve substance, but that such changes as do occur are secondary to the circulatory disturbances. If the sino-auricular node is considered a neural structure, which I do not accept, our findings are the opposite of those reported by Obersteiner and Bagg. The node is rather to be considered a muscular structure.

It will be noted that the glass tube was found in only one of the four long term experiments, a fact which I am unable to explain.

Dog 6 represents the relatively early changes subsequent to introduction of the tube. In this animal, the essential pathological change was hemorrhage. The two large vessels near the node were intact, although there was considerable red blood cell infiltration into the node. Dog 13 probably represents the end result of such trauma.

The effects of radium emanation upon the blood vessels coincide in general with those in other studies, including those referred to previously in this paper. Two observations, however, do not appear to have been previously described. The first is the great resistance exhibited toward radiation by the elastic coats of the larger vessels. In some instances, although the remaining coats of the vessels as well as the surrounding tissue were in a state of necrosis, the tunicae elasticae appeared unchanged. A second interesting fact, was the finding of only 2 cases of thrombosis and 2 cases of endarteritis obliterans in fields of strong radiation. It might be considered unusual to find patent and evidently functioning vessels in fields of strong radiation, where the coats of the vessels as well as the surrounding tissues were in a state of necrosis.

It is of interest to note that in no animal was there evidence at autopsy of pulmonary embolism, although in several animals organized clots were found in the right auricle adhering to the endocardium beneath the site of radioactivity.

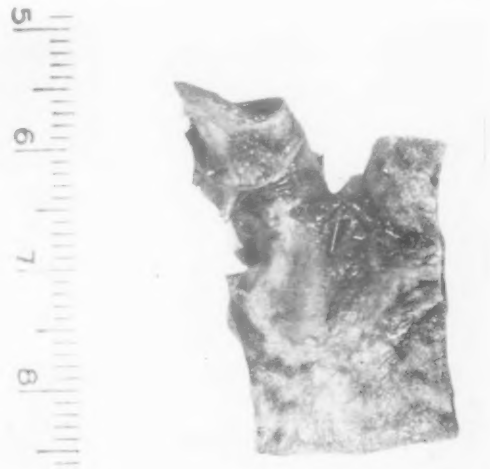

Fig. 8. Shows the cavo-auricular junction at autopsy of Dog 11 after the adherent pericardium and visceral pleura had been gently dissected away and the tissue fixed in formalin. The tube may be seen partially withdrawn cephalically to render it visible. Marked evidence of damage may be seen grossly. (For size, see centimeter scale.)

The site of each sino-auricular node as observed in this series does not correspond exactly to previous descriptions in the literature. In my opinion, three landmarks to be emphasized in an anatomical description of the node are (1) the exact junction of the superior vena cava and the right auricle; (2) the bundle of muscle fibers almost invariably seen grossly on the endocardial surface beneath the sulcus terminalis, known as the crista terminalis, and (3) the nutrient vessel or group of vessels. In all these animals, the node was seen in the substance of the crista termina-

lis, contiguous to the superior vena cava, and just beneath the epicardium.

The node has usually been previously described as club-shaped. I have never observed the typical club-shaped node. The cephalic portion usually begins as a small group of fibers, and gradually in the course of 1 or 2 millimeters it assumes the size seen in the body of the node. If our methods of differentiation of the nodal tissue were further perfected it is probable that the cephalic portion of the node could be seen tapering off still further from a larger to a smaller bundle of fibers.

The difficulties encountered in the accurate introduction of a fragile glass tube into a pulsating tissue, 2.0 cm. in length, 0.5 cm. in width, and 0.3 mm. in depth, under sterile precautions, made the problem surgically very interesting. We were able in ten instances in this series to pass the tube either directly into the nodal tissue or contiguous to it.

SUMMARY

Using sterile technique, radium emanation in glass tubes was inserted sub-epicardially into the sino-auricular node region in 14 dogs. The strength of radium emanation varied from 0.6 to 5.0 millicuries. The tubes were left in place for periods varying from eight hours to eight months. The post-mortem tissues were mounted in paraffin, sectioned serially at 10 micra thickness, and stained, some with Van Gieson and hematoxylin stains, and others with eosin and hematoxylin.

CONCLUSIONS AND DEDUCTIONS

1. The sino-auricular node is more sensitive to the action of radium emanation than the surrounding tissues; hence,

2. The sino-auricular node might be considered to be more primitive than the adjacent structures.

3. The effect of very small doses of radiation or the early effect of larger doses on small vessels in this region is first an engorgement, and later a rupture of the wall with resulting hemorrhage into the surrounding tissue.

4. While obliteration of the lumina of the larger vessels at the cavo-auricular junction may occur, it does not usually follow irradiation under the conditions of these experiments.

5. The elastic coats of the larger arteries of the cavo-auricular junction display great resistance toward radium emanation rays.

6. The anatomical site of the sino-auricular node is more accurately described as being in close relation to the cavo-auricular junction, the nutrient vessels and the band of muscle fibers visible grossly beneath the sulcus terminalis, known as the crista terminalis, in which structure I have always found it practically contiguous to the superior vena cava, lying just beneath the epicardium.

7. The heads of the sino-auricular nodes in this series taper off cephalically into a very small bundle of fibers, no club-shaped nodes being observed.

8. The effects of radiation upon the sino-auricular node and surrounding tissues are disturbances in circulation, shrinkage of the cell, fatty changes, shrinkage of the nuclei, disappearance of chromatin, and karyorrhexis, followed by necrosis, connective tissue replacement and calcification.

9. The pathological changes here produced by radium emanation suggest a primary action upon the cells and nuclei, and not an action secondary to circulatory disturbances.

The author wishes to acknowledge the helpful suggestions and material assistance rendered by Dr. J. E. Sweet and Dr. E. B. Krumbhaar in the time-consuming experimental procedures which made this study possible.

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ROENTGEN DIAGNOSIS AND THERAPY OF THE THYMUS IN CHILDREN

BY

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EVEN in this era of medical progress and enlightenment, comparatively little attention has thus far been given to that very important condition known as hypertrophied thymus or status thymicolymphaticus. The statement is frequently made that this is a condition of such rare occurrence as to be relatively unimportant. Roentgenologists and roentgen therapists are thought to be prejudiced because they see a considerable number of these cases. Even granting this rather questionable point there is no doubt that the condition is present more often than is suspected.

ANATOMY

The thymus is an organ which is bilaterally symmetrical, divided into two lobes, which are subdivided into lobules, composed of a cortex and medulla. It is derived embryologically as an invagination from the third visceral pouch. The cortex is made up of lymphocytes packed together in a dense arrangement, and the medulla is made up of a cell network in which are large numbers of lymphoid cells in characteristic concentric figures—Hassall's corpuscles. The cells are strongly lymphocytic and are densely massed together. These cells are either modified lymphocytes which have migrated into the tissues, or they are of epithelial origin. The gland lies in the anterior mediastinum above the heart, in close relation to the large blood vessels, the pneumogastric, recurrent laryngeal and phrenic nerves, and anterior to the trachea.

The thymus is large in infancy and later undergoes involution and decreases in size. According to Hammar,[1] the turning point is eleven to fifteen years, or at the age of puberty. This revises the old theory of age involution to the effect that the involution does not appear until puberty. Friedleben states that "it reaches complete development at birth, remains in this condition with some increase in size until the second year, and then a retrograde process begins which is well advanced at puberty." This may be questioned, and the authors are not in accord with the above as it is not generally borne out roentgenographically.

PATHOLOGY

A review of the literature indicates that there is remarkably little upon which to base the opinion that the thymus is a gland of internal secretion, but the observations as to its relationship to the growth and development of the bony structures and of the genitals is strongly suggestive of its having some internal secretion. It is of interest to note that McKenzie[2] says: "Possibly every case in which there is a thymus persisting into adult life is one of potential or latent Graves' disease." Clinically, we must bear in mind this condition, and realize that it gives rise to very peculiar and unusual conditions, which are:

1. *Mors Thymica.* The chief charac-

teristic of this condition is sudden death in infants and children apparently in good health. Post mortem examination usually reveals a hyperplastic enlarged thymus, although frequently not large enough to make it appear as a probable cause of death. Two explanations are given as to the cause of death, one, the pressure theory, and the other, the theory of systemic disturbance (intoxication). There is a sufficient number of cases recorded in the literature to make certain that mors thymica is a clinical entity, although the symptoms show much variation.

2. *Thymic Asthma.* If the thymus is sufficiently large to produce pressure symptoms, the condition of thymic asthma may develop. This is a condition arising almost wholly in infancy. As in mors thymica, there is much uncertainty concerning this condition. It has been denied that such a syndrome exists. But within the last year two children presenting this syndrome have come within the observation of the authors. The crowing respiration and stridor were most distressing and even alarming, and one child had typical asthma-like attacks.

3. *Status Thymico-lymphaticus.* This condition is a constitutional disease associated with abnormal development of the thymic and also of the lymphatic system, which is spoken of as "persistent thymus." This is really a misnomer, the condition being one of hyperplasia of the thymus and lymphatic system. Falta describes status lymphaticus as follows: "In true status lymphaticus the involution of an already abnormally developed lymphatic apparatus is absent. We find enlarged follicles at the base of the tongue, hyperplasia of the entire pharyngeal lymphatic ring, lymphoid growth in the nose, enlargement of the lymphatic glands in the neck, in the axilla and inguinal regions, hyperplasia of Peyer's patches and red bone marrow, enlarged spleen and more or less enlarged thymus. A frequent finding is hypoplasia and narrowness of the aorta and the whole arterial vascular tract. The heart is likewise often abnormally small, although it may be hypertrophic. Commonly there is a dilation of the left ventricle, with diffuse clouding of the endocardium and frequently retardation in the development of the genitals, slight development of the secondary sexual characters, retarded onset of menstruation, and retarded, lessened sexual instinct."

This condition is much commoner in males than in females. The etiology is unknown. Chromaffin deficiency has been suggested as having some relation, and may even be an etiological factor. It is also noted that the condition occurs in families, two or three children showing symptoms of status lymphaticus.

Peterson and Miller[3] give very interesting statistics to the effect that "infants born of mothers between the ages of fifteen and twenty showed enlarged thymus in 33 per cent. In the next group, i.e. mothers between the ages of twenty and twenty-five 44 per cent of infants have enlarged thymus; between the ages of twenty-five and thirty, 52 per cent; between thirty and thirty-five, 55 per cent, and in the ages from thirty-five to forty-two, 100 per cent." They state, however, that these percentages simply indicate the tendency to thymic hyperplasia in infants born of elderly women because of the relatively small group of cases investigated. They also state that the percentages increase with the number of pregnancies; that primaparas show enlarged thymic glands in infants in only 34 per cent; that in multiparas the percentage is 66 per cent, and that the percentage steadily increases with the multiparity.

CLINICAL TYPES

States of hypofunction cannot be considered clinically and are of no interest from the standpoint of this paper. The characteristic signs and symptoms of status thymico-lymphaticus are as follows: Probably the outstanding sign is dyspnea of varying severity and accompanied by a peculiar crowing inspiration, known as thymic stridor. This is unquestionably a characteristic sign. Dyspnea and cyanosis may or may not be present, depending upon the size of the thymus. Another prominent symptom is holding of the breath or temporary cessation of breathing, which was formerly attributed to temper. This type of infant is undernourished, weak and puny, pasty in color,

probably with the sniffles, and prone to colds.

Several cases of idiota thymica in children are reported and illustrated by Klose.[4]

The other type is the large, over-weight infant who is very backward in walking and talking, and in whom there is a delay in the eruption of the teeth. It is this type of child that laymen consider such a wonderful specimen, who dies from some more or less trivial infection or from the administration of a general anesthetic.

It is well to bear in mind that this condition may persist into adult life. Schridde gives an observation based on 97 cases of death in men following trivial injuries. The oldest was thirty-nine years of age. Fifty-six men had hyperplasia of the medullary part of the thymus; 41 were without hyperplasia. The spleen in the thymic condition is large, the average weight being 250 grams, in comparison with the normal 115 grams. Its follicles and lymph glands are hyperplastic. Thymic men are tall, with short necks and an intersexual border of pubic hair. There is an overabundance of subcutaneous fat which is whiter than usual. Schridde states that only the hyperplasia of the medulla of the gland causes thymic death.

It is well known that proliferation or, more correctly, increase in the number of Hassall's corpuscles occurs in Graves' disease and Ewing[5] states that a similar condition is frequently found in hemophilia.

TECHNIQUE OF ROENTGEN EXAMINATION

Probably one reason that the condition is not recognized more often by the roentgenologist is the fact that the examination must be very carefully made and requires an exact technique. This technique should be so arranged that the child can be roentgenographed by merely flashing the tube, which is easily accomplished with the modern apparatus, double intensifying screens and super-speed films. The importance of this, of course, lies in the difficulty in keeping a child quiet. The exposure should be made as follows: The child is held erect by the nurse, and the plate or film is held against the child's chest. This is very easily done if the nurse is instructed to hold the top of the film with her thumbs, her other fingers holding the child's shoulders tightly against the cassette. The thymus changes in size with the respiration and crying of the child. It is therefore advisable to make an exposure of the child while crying. To obtain roentgenograms at inspiration and expiration in infants is a difficult matter because it is impossible to have them hold their breath, but if one watches closely and exposes the

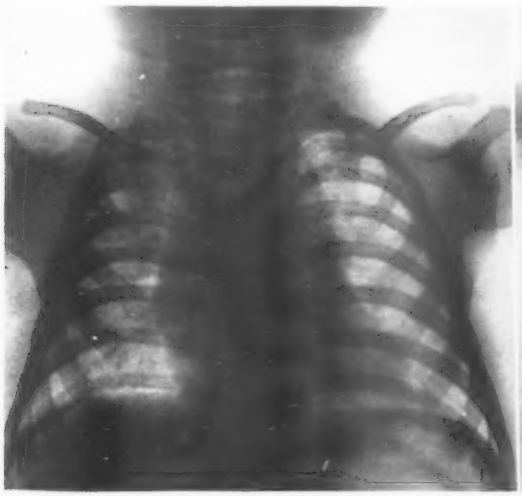

FIG. 1.

FIG. 2.

FIGS. 1 and 2. Thymic hyperplasia. Note the typical triangular-shaped shadow, the base merging with the shadow of the heart. Note, in addition, the bilateral and symmetrical character of the shadow and the definitely smooth outline.

film while the child is crying, one is certain to have a film made on expiration. Then, as the child ceases to cry and breathes in, another exposure should be made on another film, thus producing a plate on inspiration. It is also wise to repeat the process with the child lying on its abdomen and the film under the chest. There are several theories as to the cause of the enlargement of the thymus when the baby cries. One is the engorgement of the gland due to the congestion of the vessels of the chest caused by crying. The second is that the elevation of the diaphragm as the result of forced expiration pushes up the heart and mediastinal contents, causing the gland to enlarge. The latter theory is probably the more important. The fact that the diaphragm is high during forced expiration is easily demonstrated by comparing its level with the shadow of the ribs. On full inspiration the dome of the diaphragm may be opposite the eighth rib, whereas on full expiration it will rise to the sixth and perhaps even to the fifth rib.

The importance of the above mentioned technique can be readily understood as there must, of course, be some definite method by which exactly the same conditions can be reproduced, in order to check up the size of the gland to see what reduction has been accomplished by roentgen therapy. The roentgen appearance of the shadow of the thymus is well known, and has been well described by Lang, Grier[6] and others. However, in passing, it might be well to mention that the shadow of the enlarged thymus extends on both sides of the spine. Its borders are convex, which is a point in differentiation of tuberculous glands in the superior mediastinum. Also, the shadow is wider below than above, and merges with the shadow of the base of the heart. It is quite symmetrical on both sides and fits down over the base of the heart like a hat. This differentiates it from the shadow of a substernal thyroid, which is wider above than below. The shadow cast by tuberculous mediastinal glands is commonly denser; its borders convex; and it is wide near the root of the lungs because of the involvement of the lower group of nodes.

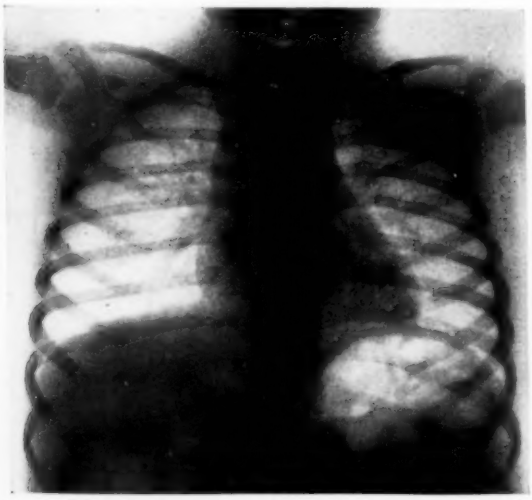

Fig. 3. Thymic hyperplasia. Note the typical triangular-shaped shadow, the base merging with the shadow of the heart.

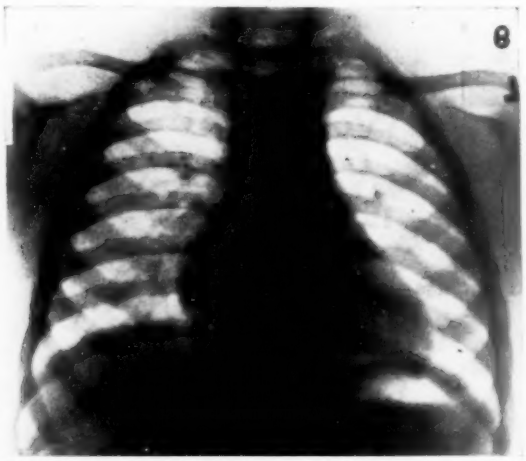

Fig. 4. Normal child's thorax. This is the same patient shown in Figure 3. The roentgenogram was taken after four roentgen-ray treatments had been administered and shows disappearance of the enlarged thymus.

Symptoms. While in the majority of cases of thymic enlargement the condition can be diagnosed roentgenographically, the clinical symptoms must also be considered in reference to treatment. Frequently in an apparently normal child the roentgenogram will show an abnormally developed thymus, and even more often the clinical symptoms of difficult breathing, choking, the peculiar crowing breathing, and inability to swallow without lowering the head,

will be marked, while the roentgenographic findings will be negative. Therefore in the selection of cases for treatment, both the roentgenographic and clinical findings must be considered. Gray and Pancost, in discussing a paper on the thymus by DuBuys, Samuel and Bowie,[8] lay particular stress on this fact. In those cases in which clinical symptoms are pronounced, even though the roentgenographic findings are negative it seems advisable that treatment be instituted and at least a single treatment be given, with perhaps a favorable outcome and with the assurance that no harm can result if proper technique is employed.

TREATMENT

Operative procedure has been advised and practised, but the results have been most unsatisfactory and the percentage of mortality extremely high. Parker[8] reports a case in which he did a thymectomy. He also reports a series of 50 cases operated on by several competent surgeons, and in this series there is a mortality of 33⅓ per cent. Parker also states that the entire gland is probably never removed because of the normal fixation of certain parts of the gland in the capsule. This fact, together with the high mortality, both directly from the operation itself and the danger of immediate death from the anesthesia, may be considered quite sufficient evidence against surgical procedure.

Radium. Radium has been employed with general success by numerous operators, but as it is often not available, its use cannot become universal. Again, owing to the uncertainty of dosage, its use cannot be generally practical, and only in the hands of one thoroughly versed and experienced in its use is it safe.

Hardy reports 18 cases of enlarged thymus in which radium was used. In 6 cases untoward symptoms arose subsequent to radium treatment. In one case bronchopneumonia, in a severe toxic form, developed on the second day following the use of radium, and resulted fatally. In another case the patient suffered from convulsions for a week. Other complications consisted of subnormal temperature and cyanosis; severe convulsions associated with periods of cyanosis; increase in the cough, cyanosis and suspended respiration occurring during the week following the use of radium.

It is to *roentgen rays* therefore, that one must turn for a method of treatment in this condition that is at once available, practical, easy of application, and, in competent hands, safe.

Various methods have been advocated for the use of the roentgen ray in this condition, both as to the amount of radiation and the frequency of application. Filtration of from 1 to 4 mm. aluminum has been used, and exposures of from one-tenth to one-half a filtered erythema exposure, with a voltage of from sixty to eighty thousand. The method chosen will naturally vary with the preference of the individual operator. The method used in the clinic of the New York Hospital is as follows: an 8 inch spark gap, 5 ma., 10 inch distance, with an exposure of 1¼ minutes, and a filter of 3 mm. of aluminum. This gives approximately one-tenth of a filtered erythema exposure. Two areas are exposed at each treatment, anterior and posterior. A second exposure is given in a week or ten days, depending on the results obtained from the first exposure. At this time it may be necessary to increase the time to 2 minutes, other factors remaining the same. If the condition is not entirely eradicated following the second exposure, a third irradiation is administered at the end of two weeks, and if subsequent exposures are necessary, they are given at intervals of two or three weeks, the average number of treatments required being four or five. The number of treatments is governed primarily by the symptoms, although control roentgen examinations are made just previous to each exposure. However, one is not to be discouraged if the gland shows no appreciable diminution in size on the roentgenogram, providing the symptoms are benefited.

It might be well to call attention to the fact that in the treatment of this condition, either by radium or roentgen rays, great care must be exercised not to administer too large a dose at the first treatment, particularly in those cases in which there is marked hypertrophy of the thymus or in which the symptoms are markedly severe,

as there is danger of too rapid absorption of the gland, and also of congestion, causing an increase in its size, and accompanied by an aggravation of the symptoms and the possibility of a fatal outcome. In one case observed, following the usual exposure there occurred after a few hours, a sudden increase in symptoms, the child becoming extremely cyanotic, and a fatal result was apprehended. These untoward symptoms slowly abated, however, and the end result was satisfactory. There is also another procedure in therapy which is used if there is any question that the thyroid may receive either some direct or scattered radiation. This therapy consists in administering small doses of Lugol's solution or five drops of tincture of iodine in three-quarters of a glass of water, giving a teaspoonful three times a day for about two days following each treatment.

In conclusion, from the observation and treatment of a large number of cases, it may be confidently stated that the roentgen ray offers not only a highly satisfactory method of treatment of enlarged thymus, but, in practically all cases, a safe and certain cure.

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ROENTGENOGRAPHY OF THE SPINE*

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TODAY, with powerful transformers and coils, films with an extra sensitive emulsion on both sides, and double intensifying screens, rapid exposures can be made which eliminate the blurring produced by the movements of the patient during the exposures and which consequently give sharp images of the structures, while the Potter-Bucky diaphragm eliminates the fog due to secondary radiations. These factors have made lateral roentgenograms of the spinal column possible and the importance of this is being fully realized in diagnosis. The relative value of the anteroposterior and lateral roentgenograms are shown in the histories of the following cases.

Case 1. The patient, Gunner C. was wounded at 10 p.m. on August 2, 1915. He walked to the dressing station for the night. Next morning he was sent to the Base Hospital. Here it was noted that he had a small scar on the side of his neck. A roentgenogram showed a rifle bullet on a plane with the 7th cervical and 1st dorsal vertebrae. The bullet was localized as lying in front of the vertebral bodies, and an unsuccessful attempt was made to remove it.

After the operation a further roentgen localization was made which proved that the bullet had not been moved. The patient at this time complained of pain in his right arm and hand. He was transferred to another hospital where the bullet was again localized as lying in front of the vertebral bodies, and a second attempt was made to remove it. After exploring the tissues in front of the vertebral bodies for

* Read before the British Orthopaedic Association in October, 1926.

several hours the operation was stopped before the bullet was found. It was decided to tell the patient that the bullet had been found, as, in the position indicated by the roentgen report, it could not be causing the pain of which he complained. After convalescing he was sent to his regiment. Here he again reported sick. He was roentgenographed, the bullet was shown and he was sent to England. A further localization was made and the same opinion

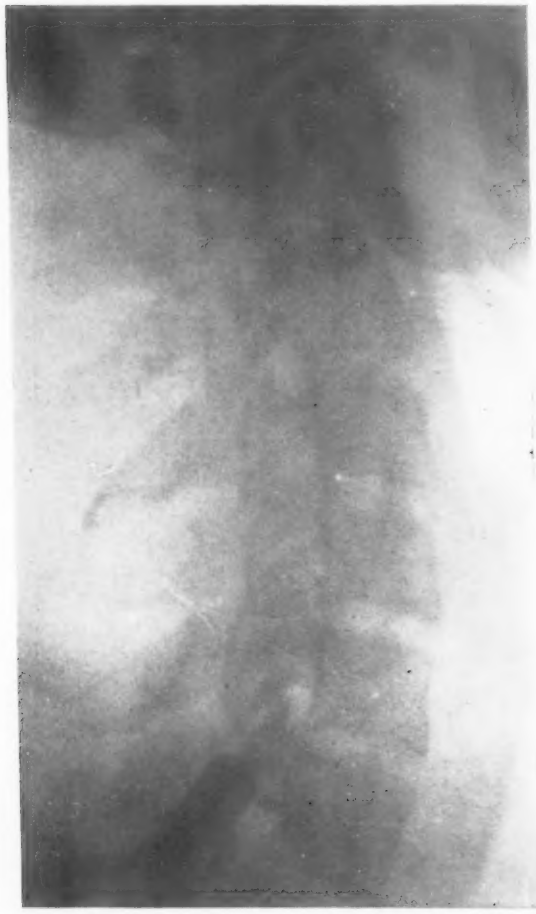

Fig. 1. Lateral roentgenogram showing a rifle bullet in the spinal canal.

expressed as to the position of the bullet. In view of his history and the fact that he had completed fourteen years' service he was discharged. After one month's leave of absence he again volunteered and was sent to his Depôt and then to France.

His symptoms were increased by an explosion near to him and he reported sick. The bullet was for the fourth time localized as lying in front of the vertebral bodies and he was prepared for a further operation, but as the hospital had to be cleared, he was sent to England to the Second Birmingham War Hospital, two years after his injury, where he came under my charge.

The roentgen report from the last hospital read as follows: "Rifle bullet lying diagonally across the front of the last cervical and 1st dorsal vertebrae, base upwards, point downwards. Point 8.3 cm. deep from the blue mark on back."

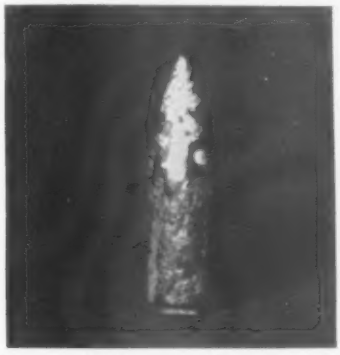

Fig. 2. Photograph of extracted bullet—much eroded.

Anteroposterior roentgenograms were made and by the triangular method of localization the following details were obtained. The bullet was lying in the midline at the level of the 7th cervical and the 1st dorsal vertebrae 2¾ in. deep to a metal marker placed on the skin on the front and 3 in. deep to a marker on the skin on the back of the neck.

Stereoscopic roentgenograms were made (as his history sheets stated had been made before) but it was impossible to state the relation of the bullet to the bone.

A lateral roentgenogram taken in the usual manner just missed the bullet, but by taking a further roentgenogram while the head was held firmly and the arms at the sides pulled towards his feet, a picture was obtained which showed the bullet lying in the spinal canal at this level (Fig. 1).

Dr. Furneaux Jordan removed the laminae with the spinous processes of the vertebrae and exposed the cord. No bone abnormality was seen and it was not until a needle had been pushed through the dura that the position of the bullet was determined. The dura was then incised and the eroded bullet was removed—two years after its entrance (see Fig. 2). The patient made an uninterrupted recovery and was finally sent to his depôt.

This case illustrates the difficulty of estimating the position of a foreign body

in relation to the spinal column by the best methods of localization by anteroposterior roentgenography, and the value of the lateral roentgenogram.

Case II. Miss J. F., aged thirteen. This girl did not walk in a normal manner as a child; she always had difficulty in bending forward with her knees straight.

September, 1922. Patients walks with a definite waddle, the feet everted. There is the appearance of shortening of the lumbar spine, a lumbosacral prominence and a left lumbar curvature. On flexion, which is limited, there is a general prominence of the spine on the right side. The other movements of the spine are normal.

A roentgen examination was made about this date, which showed that there were some destructive changes of the 4th lumbar vertebra. No lateral roentgenogram was taken.

In May, 1923, Dr. Naughton Dunn put on a plaster corset and extended the spine by suspension.

In September, 1923, the plaster cast was replaced by a block leather support, which she has continued to wear. Spinal exercises and instructions in walking have been continuous.

On January 1, 1926, she was sent to me for a roentgen examination of the spine. The roentgenograms (Figs. 3 and 4) show the nature of the bone deformity.

The lateral roentgenogram shows that the lumbar vertebrae have "slipped" forward at the lumbosacral joint so that the inferior surface of the 5th lumbar body is opposed to the anterior surface of the 1st sacral body.

Fig. 3. Fig. 4.

Figs. 3 and 4. Anteroposterior and lateral roentgenograms showing spondylolisthesis. The inferior border of the 5th lumbar vertebral body is opposed to the anterior surface of the 1st sacral body. Further dislocation is checked by the spinous process of the 5th lumbar which has become hollowed out to articulate with the superior border of the 1st sacral body.

The superior surface of the 1st sacral body is articulating with the modified and hooked spinous process of the 5th lumbar vertebra. The anteroposterior roentgenogram shows the 5th lumbar body lying as a denser crescentic mass over the upper part of the sacrum, but the nature of the lesion is not shown.

Case III. Mr. T. P., aged forty-seven, was sent to the roentgen department for an investigation of the alimentary tract, with the provisional diagnosis of "carcinoma of the splenic flexure."

During the preliminary screening of the thorax, the heart shadow appeared to be a little elevated above the diaphragm (Fig. 5). In

answer to questions the patient stated that he complained of pain in the back, which had been continuous for two years in spite of many kinds of treatment. These factors suggested to me the possibility of aneurysm of the abdominal aorta and with the idea of attempting to show erosion of the vertebral bodies, anteroposterior and lateral roentgenograms of the spine were taken. The anteroposterior roentgenogram showed some "lipping" of the lower dorsal and upper lumbar vertebral bodies

Fig. 5. Anteroposterior roentgenogram of the thorax showing elevation of the heart shadow above the diaphragm by a body with a convex upper border—aneurysm of the abdominal aorta.

suggesting osteoarthritis but the lateral roentgenograms showed the characteristic "scalloping" of the lumbar vertebral bodies by aneurysm and the diagnosis of "aneurysm of the abdominal aorta" was made. This erosion of the vertebrae is quite different from the erosion due to tubercle, gumma or new-growth. In these latter diseases the erosion is not confined to any particular plane or tissue, and the general structure of the bodies is destroyed and consequently they collapse; whereas in aneurysm the erosion is a slow with simple surface "scalloping" of each body. The intervertebral discs can resist the erosion of the aneurysm, and the bone in close relation to the discs is protected by them, so that it is possible to have a series of vertebral bodies eroded and yet preserving the general form and spacing of normal vertebrae. Thus an anteroposterior roentgenogram may show little or no destructive change, while the lateral view shows marked erosion. These features are well shown in Figures 6, 7 and 8. When the patient was admitted to hospital I obtained from him the following history: In September, 1923, he first began to have pain over the middle of the back, which was of a dull gnawing character with occasional sharp stabs, at all times of the day and night. In February, 1924, he was sent to the hospital, where he was examined and

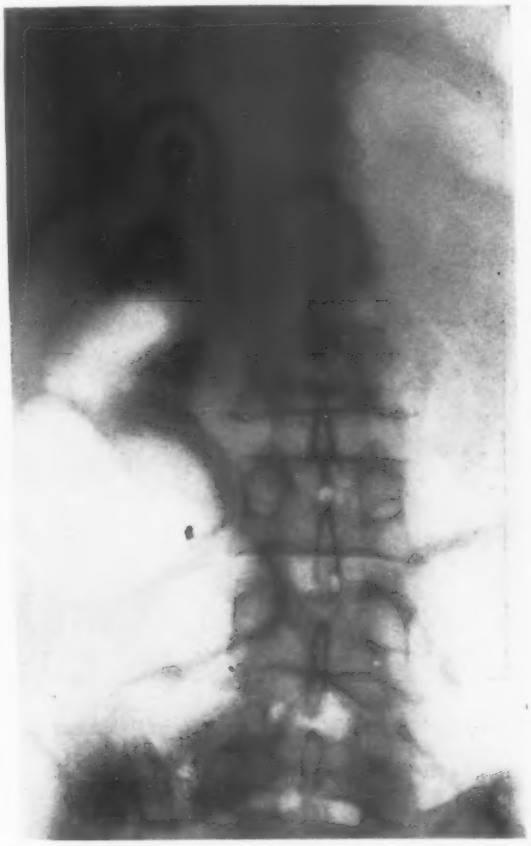

Fig. 6. Anteroposterior roentgenogram showing lipping of the lower two vertebral bodies. On closer inspection it will be noted that there is some erosion of the opposite side of these bodies and of the upper three lumbar bodies as well as the head and neck of the 12th rib.

roentgenographed. No abnormality was found and he went back to his work. In April he attended the hospital and was recommended for electrical treatment for lumbago. He continued this treatment for three months and then tried to work again, but the pain grew worse. He was therefore sent by his doctor to see a surgeon who had him roentgenographed. The roentgen report stated that he had arthritis of the spine.

He was sent to Droitwich for three months to have the baths and massage. On returning he complained that the pain was worse and was therefore sent into the hospital for further investigation. It was now reported that he had an enlarged heart. A further roentgen investigation was made and it was reported that the stomach was normal but that he had osteo-arthritis of the spine.

The pain continued in spite of all forms of treatment and his doctor sent him into another hospital for investigation in July, 1925. Here the patient found that he was numb over the left hip-joint in front, i.e., he could pull hairs out in this region without feeling pain. He was roentgenographed and the diagnosis of osteo-arthritis was confirmed. He was therefore advised to go back to work as lying in bed would make him a chronic invalid. Early in October, 1925, he called his doctor's attention to a lump in his left side. He was then sent to the Queen's Hospital, Birmingham, with the diagnosis of "twisted Kidney." He was examined by a surgeon who then sent him to the roentgen department for an alimentary investigation with the provisional diagnosis of "carcinoma of the splenic flexure."

The diagnosis of aneurysm of the abdominal aorta was then made. A month after this, while straining to micturate, he had an agonizing pain which caused him to faint. After this a definite tumor could be felt on the left side of the abdomen.

Two weeks later, on Nov. 29, 1925, he sat up in bed, lit a cigarette and fell back dead.

Post Mortem. On opening the thorax a large clot of blood was seen to occupy the left side of the pleural cavity. The left lung had collapsed. The clot, which was a complete cast of the left pleural cavity, was lifted *en masse* and a large hole, enough to admit three fingers, was disclosed in the dome of the left diaphragm. The heart and thoracic aorta appeared to be normal. The abdomen was opened and the left kidney was seen displaced forward to the anterior adbominal wall, which accounted for the diagnosis of twisted kidney. The stomach and intestines were removed and the aorta exposed through its whole length. It appeared to be quite normal on its anterior aspect, but on dissecting it out, the posterolateral borders in the region of the celiac axis were found to be continuous with the borders of a large swelling lying on both sides of the vertebral column.

Fig. 7.

Fig. 8.

Figs. 7 and 8. Lateral roentgenograms showing erosion of the anterior surfaces of the last dorsal and the three upper lumbar vertebral bodies. The bone in contact with the discs, which are unaffected, is not eroded; the bodies have therefore not fallen together.

On the right side the sac appeared as a fairly thick fibrous-walled, blood-containing cavity, but on the left side, the psoas muscle fibers were dissected apart and the fibrous sheath of the muscle distended by a large blood clot which appeared to be about a week old. This clot extended to the inguinal region and was limited by the muscle sheath in all directions (Fig. 9).

Dr. C. C. W. Maguire made the post-mortem examination and I am indebted to him for the following description of the sac. "The sac communicates with the aorta at the level of the 11th and 12th dorsal vertebrae and has extended downwards and backwards on either side of the vertebral column so as to form a somewhat horseshoe shaped cavity, the left limb being longer than and having twice the cubic capacity of the right limb. Its lower limit is at the level of the 1st sacral segment on the left side and at the level of the disc between the 3d and 4th lumbar vertebrae on the right side. Posteriorly, it is in direct relation to the last rib and transverse processes of the lumbar vertebrae and to the muscles of the posterior abdominal wall. The incorporation of these muscles into the walls of the sac has been the means of partially arresting its development posteriorly. In front of the sac the kidneys and other abdominal viscera are displaced forwards. The posteromedial walls of the sac are formed by the vertebrae and intervertebral discs. A windowpane dissection reveals an extensive erosion of the bone of each vertebra, while the intervertebral discs are almost unaffected. Superiorly, particularly over the left side, the cupola of the diaphragm is so atrophied and stretched by pressure as to be reduced to a thin layer of fibromuscular tissue about 1 mm. in thickness. It is through this muscle posteriorly that the aneurysm has ruptured into the left pleural cavity. The heart shows only slight evidence of hypertrophy."

The histories of the 3 preceding cases show that it is essential in investigating pathological conditions of the vertebral column to take anteroposterior and lateral roentgenograms in every case. As a general rule, it may be said that more information is obtained from the lateral than from the anteroposterior roentgenograms, but each plane shows well-marked characters in each disease. These factors are probably well known to all roentgenologists but the histories of these cases show that there is a tendency to be satisfied with the anteroposterior view if no gross change is shown on it; the diagnosis in all these cases was missed by this error.

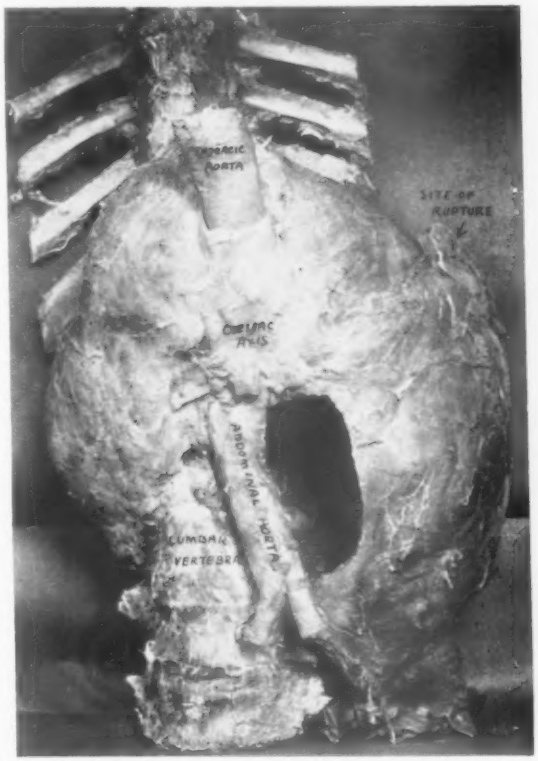

FIG. 9. Photograph of the aneurysm of the abdominal aorta with a window to show the erosion of the vertebrae and the projecting intervertebral discs. It shows that the thoracic and the anterior aspects of the abdominal aorta are normal in size and appearance.

THE DIAGNOSIS OF PYLORIC ULCER

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BRNO, CZECHOSLOVAKIA

THERE has been comparatively little written so far on the diagnosis of pyloric ulcer, and it may be stated at the outset that the majority of roentgenologists are of the opinion that, with the exception of pyloric stenosis and the rare cases of a proof of the niche, a pyloric ulcer is not recognizable.

After several years' experience I can say that a pyloric ulcer can be just as well and easily recognized as a duodenal ulcer. And just as it was very difficult for us eleven or twelve years ago to diagnose a duodenal ulcer with certainty, so I find it now quite easy to diagnose a pyloric ulcer. For just such spasms (and spasms are the chief point in question, as we know) as cause the typical bulbous deformation and therefore make possible the diagnosis of ulcus duodeni, cause also the typical deformation on the antrum prepyloricum and on the pylorus when there is an ulcer.

The method employed is simple: Common barium emulsion without sediment, and roentgenoscopy in the standing position, good accommodation of the eye, Bucky grid. It happens very seldom that the case can be more easily diagnosed when the patient is placed on the stomach. For my part I prefer roentgenoscopy to roentgenography in the first place on account of its simplicity, and secondly because often one can see only the tiny changes by a certain turning of the patient and the use of palpation, and often only the repeated observation of the small changes can make the diagnosis possible.

The roentgen examination of ulcer of the pylorus enables us to localize the ulcer pretty exactly, so that it seems to me useful to make the following divisions:

A. Ulcus prepyloricum.

B. Ulcus pyloricum, sensu strictiori,

C. Ulcus pyloro-duodenale, which passes over from the pylorus to the bulb or vice versa.

A. Ulcus Prepyloricum. This is characterized by spastic contraction of the antrum prepyloricum. According to which part of this antrum is spastically contracted we get some typical pictures (Fig. 1): The spastic defect can develop on the small curvature (*a*), or circular (*b*) or on the side of the large curvature (*c*); finally it may develop into one or two small constant spasms on the large curvature (*d*), the antrum is at the same time more or less contracted and the prepyloric part of the small curvature generally looks spastically rigid (?).

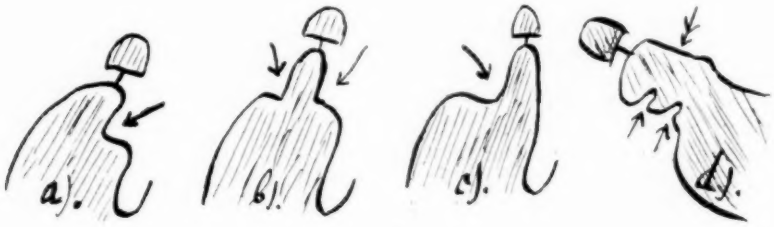

Fig. 1.

It could be decided only by observation of a great number of operated cases why these spasms vary so much in their position, although the ulcers are practically always localized on or near the small curvature.

As a second type of these prepyloric ulcers (Fig. 2), there are those in which the antrum is prepylorically pointed, and namely, from a slightly roof-like slope (*e*) to a sharp point (*g*). In this last form (*g*)

which is caused by chronic ulcerous changes, the differential diagnosis between ulcers and cancer is usually rather difficult.

It goes without saying (as it is clear to every roentgenologist) that all these changes can come not only from the ulcers but also from post-ulcerous processes (scars and ulcerous infiltration) and cannot be distinguished as such up to the present. According to my experience the shape (*d*) is to be found often with post-ulcerous processes.

B. Ulcus Pyloricum. The indications of this ulcer are especially changes which we can see on the pyloric band. Also these changes are quite typical, and often make the diagnosis possible at the first glance. Sometimes again they need a very precise examination with careful palpation and turning of the patient, and eventually repeated examination after about half an hour. The typical changes from which one can make the diagnosis are the following (Fig. 3). The pyloric band (⟊) is lengthened, sometimes also widened. We can generally say the more advanced the case is, the more the pyloric band is lengthened and the more it is convexly bent at the left (*b*, *c*).

Its opening into the bulb comes nearer and nearer to the side of its small curvature, so that the duodenal bulb becomes asymmetrical (*b*, *c*).

pyloric band or at its base and corresponds to a niche.

In very advanced cases one can find the antrum almost completely contracted, or irregularly deformed so that the differential diagnosis from cancer is very difficult to make. It was easier in case Figure 4, *f*, where the presence of the niche and the deformed bulb indicate that it is very probably an ulcer.

Fig. 2.

A further indication of a pyloric ulcer is the cone-shaped widening, and usually also the prolongation of the pyloric band (g ⟊) (Fig. 5).

Also in these cases it is necessary to be careful not to confuse it with a circular carcinoma.

C. Ulcus Pyloro-duodenale. There are very many cases, as is known, where the ulcer lies partly on the pylorus, and partly on the bulb. Usually these ulcers are diag-

Fig. 3.

Nearly always one can see there a further change of the antrum, namely, a shallower, or a deeper one but always a narrow prepyloric spasm of the small curvature (⟊)(*b*)(*c*) which splits the antrum prepyloricum into two usually unequal parts, and the part of the great curvature is generally retracted to the left (*c*).

One finds not rarely on the pyloric band a little barium spot, which is either close to the bulb, or in the middle of the

nosed as ulcus duodeni, also when they lie almost entirely on the pylorus. The explanation of this is, that in these ulcers changes occur on the bulb—even if sometimes only temporary—and therefore the changes on the pyloric band and eventually also on the antrum remain unnoticed. Although this distinction has only a theoretical value, it is still useful to know it, to make possible an exact diagnosis.

As the name pyloro-duodenale indicates

there are here visible changes on the pyloric band or on the antrum prepyloricum and on the bulb (*a*, *b*, *c*) (Fig. 6).

From these changes one can deduce with comparative exactitude the following: At (*a*) where the changes on the antrum and pylorus are well and typically developed, and the deformation on the bulb is only slight, we can conclude that the ulcer is most probably and almost exclusively on the pylorus. In (*b*) and (*c*) it is clear that

Fig. 4.

Fig. 5.

the ulcer lies both on the pylorus and on the duodenum.

Herewith there are given all the most striking changes on the pylorus, which make possible the diagnosis of the ulcer, or of the post-ulcerous process. However, it is not asserted that every pyloric ulcer can be really diagnosed. There always remain cases which escape recognition. We have seen, for example, *the gradation* of the changes in the diagnosis of pyloric ulcer. This order of gradation according to my opinion is not complete because at the beginning of this order we meet with small changes which we are not certain if they are of no importance, or if they already represent a change characteristic of an ulcer; for example one-sided flatness of the antrum, or thickened not lengthened pyloric band.

The correctness of my statements has been confirmed by operations and in every case an ulcer or scar has been found. Also the success of the treatment of the ulcer, after which the characteristic spastic changes on the pylorus have lessened or entirely disappeared prove the correctness of the diagnosis.

In general, it may be said similarly of the ulcus duodeni, the more pronounced the deformations, the more pronounced are the anatomical changes which the ulcer has caused.

It remains to discuss briefly in what way the remaining part of the stomach is functioning. One must say that the indirect symptoms being compared with the direct changes described are not at all characteristic.

The form, size and position of the stomach are normal except in cases of stenosis.

The tonus is always locally increased on the pyloric part, but the small curvature is only rarely spastically shortened, and the remaining part of the stomach is also only rarely in a more pronounced way hypertonic. The peristalsis except in the case of stenosis is normal.

Local sensitiveness is an uncertain symptom. Sometimes it corresponds with the ulcer, and sometimes it is outside the stomach in the epigastrium; frequently it is entirely absent.

Fig. 6.

As far as the motility is concerned the idea of the pyloric ulcer is, in the doctor's opinion, always connected with an obstruction of the passage. This idea is incorrect. The motility in pyloric ulcer, except in cases of organic stenosis, is either normal or accelerated. The longer duration of the spasm of the pylorus is an exception. Generally the emptying begins after the taking of barium and continues uninterruptedly till the emptying is complete

which generally takes from one and a half to two hours. One is sometimes astonished in cases of callous ulcer at the rapid motility.

From this it is to be seen that one must devote the greatest attention to the local changes. Very often the detection is easy. But there are frequently cases which seem to be chemically and anamnestically certainly a duodenal or pyloric ulcer, without indicating a single direct or indirect symptom at the roentgen examination. In such cases a second roentgen examination is to be recommended after about half an hour. It happens sometimes—usually in milder cases—that only during digestion does a sufficient irritation of the stomach take place; and therefore the characteristic spasms appear only later, making then possible a trustworthy diagnosis.

HERNIA OF THE DIAPHRAGM

WITH REPORT OF CASE OF THE CONGENITAL VARIETY COMPLICATED BY PERIODIC ROTATION OF THE STOMACH

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HERNIA of the diaphragm may be described as a defect or absence of a portion of the diaphragm through which the stomach and sometimes other abdominal organs pass into the thoracic cavity.

Congenital hernia, which comprises by far the larger number, may produce symptoms from birth, or may be found only at the autopsy. Practically all are through the esophageal opening, which has been pointed out as the only one that is muscular and therefore amenable to dilatation.

Acquired hernia, due to trauma, lacerating wounds or purulent processes, may not develop for months or years after the injury, or if it does exist, calls attention by suddenly becoming strangulated.

Usually on Left Side. Bayne-Jones reported 45 cases with only 3 on the right side. Eppinger collected 635 with 580 of these on the left.

Incidence. Up until the time of the routine examination of chest and abdomen only a small percentage were diagnosed before death. At the Mayo Clinic it has been found approximately once in every 18,000 admissions. At the present time about 1200 cases have been reported.

Symptoms are usually those of vague gastric disturbance with tenderness in epigastrium or left upper quadrant—sometimes in the gall-bladder region with pain radiating to back (some clinicians stress the frequency of low substernal pain)—vomiting or regurgitation may be present, especially if the patient assumes the supine

FIG. 1. Showing eighteen-hour barium in colon in left thorax. Bowel impinged on heart and moved freely with each pulsation. Note constriction in descending colon.

position; difficulty in swallowing is also a frequent symptom.

According to Carman and Fineman the frequent causes of failure to diagnose the condition may be: (1) It develops as a late sequel to a purulent process above or below the diaphragm. (2) Temporary spontaneous reduction may occur and examination at this time be negative. (3) Double hernias may exist and only one may be demonstrated roentgenologically. (4) Only solid organs may be herniated.

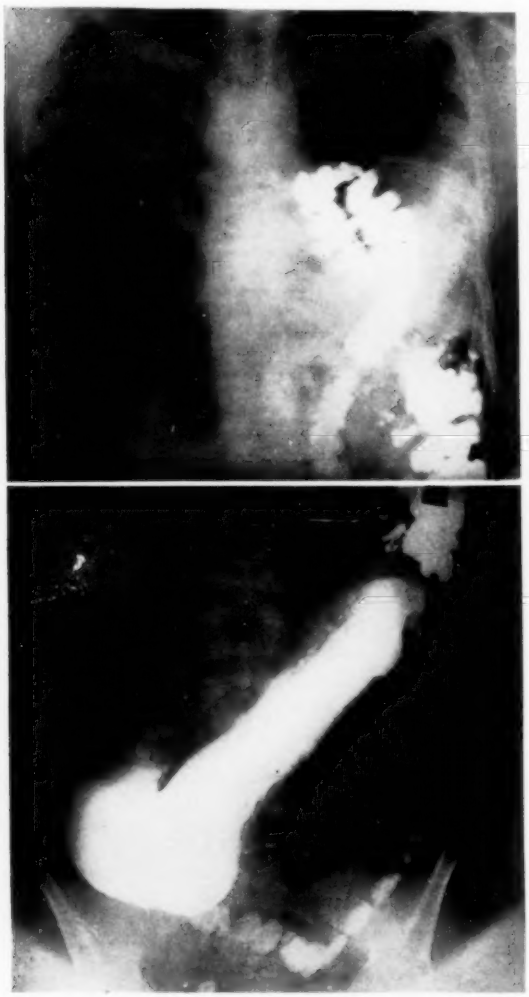

FIG. 2. Prone position. General view of thorax and abdomen; cardiac end of the stomach drawn to the left near constriction in descending colon; lower end of the stomach in right iliac fossa.

Differential Diagnosis. A. From eventration of the diaphragm, which differs from hernia in that the diaphragm remains intact, but in an elevated position.

B. It may be confused with the "congenitally shortened esophagus, often associated with the so-called "thoracic stomach" in which the stomach has never been below the diaphragm and the pyloric end or the first portion of the duodenum passes through a small opening in the diaphragm, corresponding to the normal opening for the esophagus" (Bailey, quoted by LeWald).

C. Diverticuli of the lower end of the esophagus may also simulate a portion of the barium filled stomach.

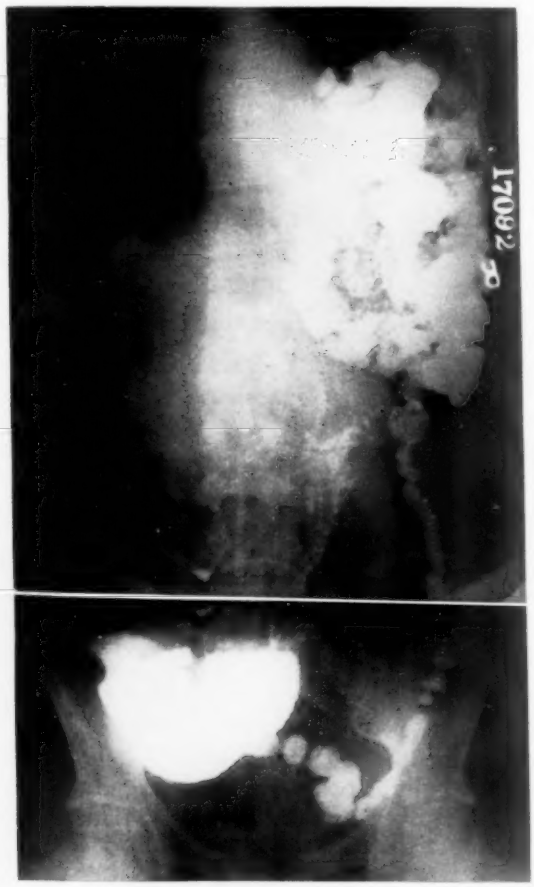

FIG. 3. Erect position. Body of stomach in right iliac fossa; small intestines seen in the left upper quadrant.

REPORT OF CASE

The reason for reporting another case of diaphragmatic hernia is the very unusual

complication of a complete rotation of the stomach, which occurs at certain intervals.

The case was referred to me for roentgen examination by Dr. H. M. Stevenson, April, 1925. The patient informed us at that time that he had recently been examined by Dr. Maurice Feldman of this city, and comparison of the films revealed the fact that the previous examination had shown a complete rotation of the stomach, while in ours the organ was lying in the usual position. Dr. N. Alpert, of Baltimore, has since reported this case in the *Medical Journal and Record*, pages 84 and 85, January, 1926—"Congenital Diaphragmatic Hernia with Complete Rotation of the Stomach," and I am indebted to both of these men for kind permission to reproduce their films and compare them with ours. As far as can be ascertained this is the first case reported of hernia of the diaphragm, with complete rotation of the stomach.

Past History. The patient is a young man, aged twenty-three, height 5 ft. 10 in., weight 136 lb., occupation salesman. He was small at birth, bottle fed, delicate, irritable, on two occasions had convulsions due to stomach upset, measles at two, slight gastric disturbances nearly all his life; since 1921 has had frequent attacks of pain in left upper quadrant, has not worked for past year.

Present Illness. Patient complains of dizziness, insomnia, frequent bloating of entire abdomen, constipation with difficult bowel movements followed by temporary relief from pain. Physical examination in supine position showed a soft movable tumor in right lower quadrant, and sometimes over promontory of the sacrum, which occasionally disappeared from the examining hand; it was not painful to touch. Liver appeared to be enlarged, no bowels could be made out in right side of abdomen.

Roentgen Examination. Examination with vertical roentgenoscope showed eighteen-hour meal in the colon, confined to left side, most of the barium was in left upper quadrant of the abdomen and in the lower two-thirds of the left thorax. That portion of the bowel which impinged on the heart moved freely with each pulsation. At a point corresponding to the usual position of the lower border of the spleen, there is a definite constriction or narrowing of the descending colon, and below this point the lumen is much smaller, almost stringy in appearance. The stomach is much elongated and very atonic. The cardiac end was drawn to the left side, probably by the same adhesions, which constricted the bowel, and then hung obliquely downward with the fundus in the right lower quadrant, organ freely movable. When barium was expelled it was found that the duodenum and jejunum were also lying in the left upper quadrant. The heart was displaced to the left and the shadow blended with that of the left diaphragm.

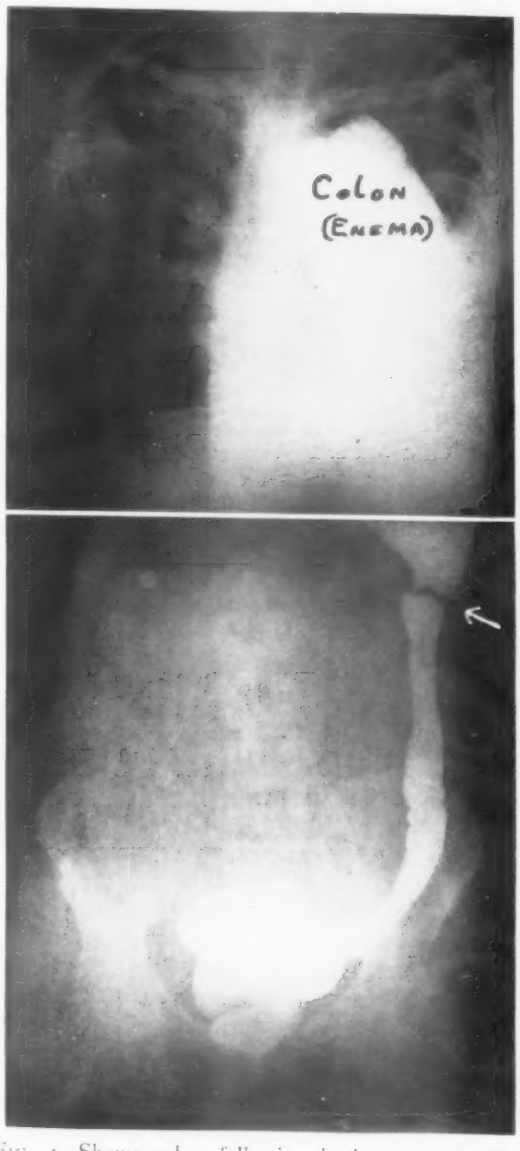

FIG. 4. Shows colon following barium enema. The upper loop reaches almost as high as the clavicle, constriction in descending colon, all on the left side. (Courtesy of Dr. Maurice Feldman.)

Barium enema also showed entire colon on the left side, the upper loop reaching almost to the level of the clavicle and the same constriction present as was noted when meal was given by mouth. It is likely that severe attacks

of pain are caused by effort of hardened feces to pass this obstruction.

Examination of films made in previous examination by Dr. Feldman showed a complete rotation of the stomach. This peculiar phenomenon has probably been brought about by adhesions, which swing the organ hammock-like obliquely across the abdomen, due to bands which fix it in the splenic region and in the right iliac fossa.

greater curvature was toward the ventral surface of the abdomen and that only in the direct lateral view could the lesser curvature and duodenal cap be seen.

Even in the much changed relations usually seen in a case of diaphragmatic hernia, rotation must be exceedingly rare, and it was probably because of the peculiar attachment of adhesions that it occurred

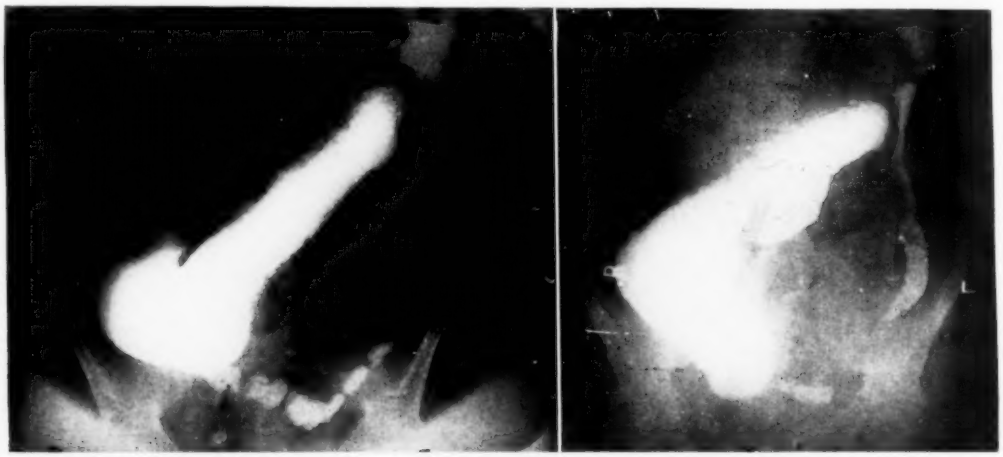

Fig. 5. Prone position. Stomach as seen in Figure 2 compared with organ when completely rotated. Note greater curvature is now to right and pylorus and cap toward the left side. (Courtesy of Dr. Maurice Feldman.)

McMurrich in "The Development of the Human Body, A Manual of Human Embryology," 7th edition, pages 305 and 306, says: "The elongation of the stomach early produces changes in its position, its lower end bending over toward the right, while its upper end, owing to the development of the liver, is forced somewhat toward the left. At the same time the entire organ undergoes a rotation about its longitudinal axis through nearly ninety degrees, so that as a result of the combination of these two changes, what was originally its left surface becomes its ventral surface. Hence it is that the left vagus nerve passes over the ventral and right over the dorsal surface of the stomach in the adult."

Swope, in reporting a case of congenital diaphragmatic hernia in a child four days old, calls attention to the fact that the

in this patient. It is hoped that further study will determine the cause of rotation and other interesting data.

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Vol. XVIII, No. 2

ROENTGEN RAYS AND THE AUTONOMIC NERVOUS SYSTEM

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RADIOLOGY, a young science, affords many suggestive problems for study. On the autonomic nervous system the effect of roentgen rays apparently shows most contradictory results. These are usually overlooked, which is unfortunate. We understand today by the term, "autonomic nervous system" all the involuntary innervation of the body, and we are inclined to believe that this system controls the vital function in the individual cell as well as in the whole organism. For this work two systems of the autonomic nervous system have to be present, one which gives the impulse and stimulus to growth and anabolism, the other which holds back this stimulus for building and growing, allowing each organ and cell to do just the right thing, not too much and not too little. Langley (1905) gave this dual system the name "autonomic system," and distinguished parasympathetic and sympathetic in preference to the term "vegetative nervous system" which does not express clearly enough the function of this system. We speak also of an "efferent" and an "afferent" movement, and understand by the term "efferent" all nerve impulses which are going from the centers to the periphery, while "afferent" autonomic nerve fibers are those which go from the periphery to the center, and are not yet found. But we must understand that the efferent system has two functions, stimulation and retardation. We wish to demonstrate that the ideal roentgen-ray treatment consists in bringing this system into balance. From these findings many problems which have been variously explained seem to become better understood, and the cancer question, looked upon from that point of view, offers a newer and larger field for research. This article is a preliminary treatment of the subject, which, it is hoped, may prove an incentive to others to work along the same line, for as we see today, it is impossible to work out, alone, the many problems involved.

Many words and terms have been used to explain certain signs observed in roentgen and radium work, which may not be understood by those who are unfamiliar with this branch of medicine. For instance, the term "distant effect" means any phenomenon observed outside of the irradiated part of the body. The terms "stimulating effect" and "irritating effect" have their origin in the pharmacological law which says: "Small doses irritate, large doses paralyze, and larger doses kill." This law is known in Europe as the law of Schulze-Arndt.

The first clinical observation of "distant effect" which made me think that the autonomic nervous system might play a certain rôle in the biologic effect of roentgen treatment was on a boy twelve years of age. He came to our department with both hands covered with warts (verruca simplex). After roentgen application over one hand only, the warts gradually disappeared from the untreated hand also. Similar observations are made by all radiologists. Baensch[1] described, in 1922, a case of primary cancer of the breast where the regional lymph glands disappeared when the breast tumor was irradiated, even though these lymph glands were carefully protected with lead rubber. We do not go so far as Scott[2] who saw lymphosarcomatous glands in unirradiated parts disappear in half an hour after large areas had been treated, but we have observed the distance effect too frequently to allow it to go unnoticed. Many explanations for this effect have been given, most of them being unsatisfactory. Lately Opitz, Risse, Cook and Vorlaender[3] have described animal experiment work where this distance effect is beautifully demonstrated. Opitz supposes that the autonomic nerves have something to do with it and is inclined

to assume a stimulating effect on the autonomic nerves, as it is evident that functional changes are observed in the nerves. Concerning the "stimulating effect" I have tried in a previous publication[4] to demonstrate the inaccuracy of this term used in combination with roentgen rays. We could show that the term "stimulating effect" ranged from small $\frac{1}{10}$ of an erythema dose to a full erythema dose, in various works, which is contradictory. Many publications are written today against the misleading use of the term "stimulating roentgen-ray effect," for example by Geller,[5] Lieber,[6] Ivy, Orndoff, Jacoby and Whitlow,[7] Czepa,[8] Falconer, Morris and Ruggles,[9] Nigst[10] and Pordes.[11] All of these observers explain this phenomenon differently.

Is there a possibility of the same explanation of these observations? If the autonomic nervous system should play any part in the observed "distance and irritating effect" of roentgen rays it should first be proved whether we are able to influence any autonomic nerve fibers or ganglia with roentgen rays or radium. To prove this, many animal experiments were made. The first we carried out were in the pharmacological department of the University of Erlangen, Bavaria, using an apex device of Prof. Jammins' Polyclinic. (S.H.S. tube, Wintz regenerative automat with 1 mm. aluminum filter, February to March, 1923). The details will be described in another article. The results were: a carefully insulated sympathetic in the neck of a cat treated with unfiltered or lightly filtered rays responded, in the beginning of the treatment, with a wide dilatation of the pupil. Later on, the treated part of the nerve was blocked, which meant that faradic irritation above the treated area of the nerve was effective. Dilatation of the pupil of the cat's eye was then observed. Irritation distal to the treated area showed that no dilatation of the pupil took place. The same observation was made by treating the insulated vagus in this region. We were unable to prove any change in the heartbeat during the treatment as recorded in the kymograph, but the blocking effect, by irritating the vagus proximally and distally to the treated part, was demonstrable. Microscopically, hardly any change on the part of the treated sympathetic, which was taken out immediately after the experiment, could be found. These experiments showed that roentgen rays given in certain amounts influence the sympathetic or parasympathetic nerves and a certain paralyzing effect takes place. This effect is not demonstrable by microscopic study as organic, as the time is too short. For this reason many publications of other observers have shown negative results. We cannot observe this paralyzing effect of the roentgen rays on the autonomic nerve tissues in man so clearly as we influence both branches of this system. As long as these two systems are in normal balance, roentgen or radium effect will not be biologically demonstrated, but as soon as the systems are out of balance the over-irritated part will be more influenced by radiation than the other, and this is demonstrable biologically and clinically.

Let us now very briefly discuss, in the light of these observations, the results which are established with roentgen treatment in different diseases. It will be noticed that all diseases which clinically show signs of autonomic nervous disturbances are treated with certain successful results by roentgen rays. Our experimental findings will explain the results better and more uniformly than the different writers are able to do with the term "stimulating dose."

Philips and Tunick[12] reported good results in thrombo-angiitis obliterans. They say, "the doses are essentially stimulating ones and consist of from ten to fifteen minutes' exposure alternating at weekly intervals over the mid-anterior and posterior aspects of the body, from the tenth dorsal to the fifth lumbar vertebrae in lower extremity affections, and over the cervical and upper two dorsal segments in upper extremity disturbances." Good results were obtained after five or six roentgen applications. Philips and Galland[13] reported remarkable relief of marked hyperesthesia and improvement in trophic and circulatory disturbances in poliomyelitis after roentgen treatment with the same "stimulating effect," as they explain it. Only Perla[14] opposed Philips' "stimulat-

ing effect" purely from a physiological standpoint. He concludes that there cannot be a "stimulating effect" of radiation. Perla believes that theoretically there has to be a paralyzing effect.

Borchardt and Ostrowsky[15] demonstrated that in Raynaud's disease and sclerodermia we do not have to deal with an underfunction of nerves but with an increased irritation of the autonomic nervous system. If these observers are correct paravertebral roentgen-ray treatment for decreasing the over-irritation of the autonomic nervous system would be indicated.

In angina pectoris, Jonnesco[16] reported success in resecting the autonomic nerve tissue of the neck. Groedel (Saltzmann, No. 4, p. 140) reports results with roentgen treatment in angina pectoris vasomotoria. Eppinger and Hess called asthma a vagotonia, and the disease is interpreted as vagus neurosis. Klewitz[17] obtained results in 75 per cent of the cases by treating the patient with roentgen rays over the spine. He supposed, in his earlier publication (1922) that the autonomic nervous system in this disease is influenced by roentgen radiation. Groedel's spleen treatment in asthma, where certainly some results are observed, and where Groedel again used the term "stimulating dose" is probably a protein therapy effect, but I am inclined to think that the ganglia mesenterica and coeliaca are also influenced by roentgen rays. Widal and Abrami[18] describe cases in which hyperthyroidism and asthma were found. In their opinion, a false inner secretory function is produced, giving disturbances in the autonomic nervous system, which causes asthma.

We know that in exophthalmic goiter, the cutting off of the sympathicus of the neck, produces a diminution of the secretion on the relative side of the thyroid, and roentgen treatment seems to have a similar effect on the over-irritated autonomic nervous system which leads to the thyroid. In any case, Meyer[19] irradiating a normal thyroid gland with the so-called "stimulating dose" of roentgen rays was never able to produce an increase in the function of the thyroid, and he always found a descending metabolic rate.

Since Oswald's[20] research we are led to believe that there is an alteration of the nervous system present to produce hyperthyroidism, (extra thyroid factor) and it is probably the over-irritated nervous system which we are influencing through roentgen-ray or radium treatment (paralyzing effect).

The increase of urine in oliguria or anuria in hemorrhagic glomerular nephritis is produced by Stephan[21] with the use of a "stimulating dose" over the kidneys (through 5 mm. zinc plus 3 mm. aluminum, paravertebrally, 30 minutes equals 180 Fürstenau, one skin dose for each kidney). The oliguria and polyuria are symptoms of a typical vasomotor effect, and instead of producing a stimulation we are probably quieting down a pathologically irritated sympathicus with the roentgen radiation, and the spasm of the blood vessels is thereby relieved. Vollhard also thinks that Stephan's effect, instead of being a stimulating one on the glomeruli, is an effect on the autonomic nervous system.

In diabetes, Stephan, Saltzmann and others have treated the pancreas with "irritating doses" bringing down the blood sugar to a certain degree for a limited length of time. This effect can be better explained through the paralyzing effect of the autonomic nervous system. Lately, Orndoff, Farrell and Ivy[22] have published a report of experiments with the effect of roentgen rays on the pancreas. Here Ivy states, contrary to the expressed opinion of Doub, that the submaxillary glands and the glands of the stomach cannot be "stimulated" by roentgen rays, but thinks the evidence strongly suggestive that the functional action of the pancreas can be enhanced.

In ulcers of the stomach, roentgen treatment has been used in cases where the patients refused operation and clinical cure has not proved successful. The so-called "stimulating dose" for connective tissue was used at first to explain the improvement of the patient after treatment, but it is interesting to note that in the treatment of ulcus ventriculi by roentgen rays the idea of influencing the nerve ends in the stomach by the rays predominates. The explanation of different writers of the effect of roentgen rays on these nerves is various. Strauss[23] believes that

the increased dissociation of the calcium ion under roentgen treatment produces a diminution of the vagus stimulation in the treated part, or that the increase of the H-ion under roentgen treatment stimulates the sympathicus and therefore the vagus (vasodilatation) is made to function normally, and the first sign of relief is the disappearance of pain. Since Buchholz[24] we know that intestinal pain is carried through the mesenteric or celiac ganglia to the sensory roots of the spine.

Bordier[25] treated children with infantile paralysis from fifteen to thirty days after the febrile period over the part of the affected spine, and reports good results. Bramwell[26] thinks that muscular dystrophies may perhaps be determined by disease of the sympathetic supply of the skeletal muscle. In my opinion again, an over-irritation of the sympathetic nerve, in these cases, is restored to normal functions, through Bordier's treatment.

It will be noticed that all skin diseases which are described principally in connection with the over-irritated autonomic nervous system are favorably influenced by roentgen rays. Here we would like to call attention to Hufschmitt's[27] publication. He gives a report of 2 cases in which lichen planus was cured by treating the spinal cord with roentgen rays (found empirically), and Castex and Camauër[28] have proved by 3 cases of ichthyosis that this is a manifestation of abnormal conditions in the autonomic nervous system. And so this disease, in its earliest stages, we might suggest, might be treated paravertebrally. Cases have been published in which pruritus or dermatitis herpetiformis (signs of autonomic imbalance) were observed and later cancer in an organ with the same autonomic center was found (for an example see Harf[29]).

From skin diseases one may turn to cancer of the skin and to the cancer question generally. Certainly all radium and roentgen-ray workers have frequently observed that cancer of the skin at first reacts very favorably after a certain roentgen-ray or radium dose is given. A better effect after a certain length of time through more application can be seen. Then suddenly after another dose with the same technique and skill, the cancer starts to grow wild and nothing seems to stop it. No satisfactory explanation of this phenomenon has been given. Barclay says, 'The problem of malignancy as seen by radiologists is full of contradictions." Is it not possible that consideration of the paralyzing effect on the autonomic nervous system by roentgen exposure above mentioned, will afford a better understanding of these apparently contradictory observations? Such an explanation might help to solve Barclay's famous unknown "Factor X." The idea that carcinoma develops under certain influences of the nervous system is old. Alexander Monroe,[30] 1720, might be called the father of this idea. Marshall[31] says that each epithelial cell has nerve endings, but those nerve connections, in carcinoma, are missed. Doerr[32] and others have proved it histologically. Kimura and Nakamoto,[33] in malignant tumors in men and animals never found nerve tissues, but in 23 benign tumors could always detect some nerve tissues.

We are now better informed about the autonomic nervous system (Langley)[34] and each day brings new reports in this field. We are, however, very far from a thorough understanding and must admit that between the functional relations of tissue and nerve not very much is yet known. Calcium and potassium effect on tissues, which will be discussed later, proves that both groups of the autonomic nervous systems play a certain rôle in the life of each cell. We might say that each cell is influenced: First, by the ion balance of the blood; second, through the autonomic nervous system. Zondek[35] says that it is not the ion which irritates the nerve but the nerve which influences the ion. Schilf[36] thinks it is not very likely that in the diseased organism the autonomic innervation plays a more important rôle than in the healthy body, but we are so used, in our medical education to overlook this part which the autonomic nerves play that we are forced to bring to our memory clinical symptoms following roentgen and radium treatment. It would be tedious to quote all the publications in which clinical signs of autonomic nervous disturbances following roentgen-ray treatment have been

reported. We shall only mention here, that Strauss and Rother,[37] and others explain the decrease in blood pressure after roentgen treatment as a vagus function. Hinselmann,[38] David[39] and others conclude from microscopic examination of the capillaries that the primary effect of roentgen radiation is on the nerve contractile element of the capillaries. Kottmaier,[40] Lignac and Devois,[41] and others explain roentgen sickness as a stimulative or paralyzing effect on the autonomic nervous system. Trophic changes of skin, hair and nails are observed in roentgen and radium workers. The same picture, as a sign of autonomic nerve disturbances is described in patients which were not at all influenced by actinic rays. The blood picture after roentgen treatment is the same as in a patient with a so-called vagotonic constitution.

Histopathological findings on the sympathetic after roentgen or radium treatment are, as we mentioned before, seldom observed. Terplan found in sympathetic ganglia of malignant tumors, small changes in some nerve tissue. The change consists in chromatolysis, vacuolization, loss of nucleus, plasma with large granules, or too small nuclei. Cavazzini[42] was the first to call attention to the change in the sympathetic ganglia after acute infectious disease, and his observations were later quite frequently confirmed; for example, by Laignel-Lavastine[43] and Staemmler[44] in vasomotor neurosis. The latter reported lymphocyte infiltration and thickening of the capsule. As Brüning[45] explains active inflammatory hyperemia not through paralysis but through over-irritation of the vegetative nerve, so Heidenhain's method of treating inflammatory processes with roentgen rays can be explained by the effect of the rays on the nerve.

The most generally accepted idea today concerning the effect of radiation on cancer cells seems to be that this effect should be sought chiefly outside of the cancer cell. For our working problem we have built up the following conception:

Let us suppose a cell complex is in connection with the autonomic nervous system.

Through some irritation (actinic, mechanical, chemical, of the endocrines, or infective) one of the two autonomic nervous systems (sympathetic or parasympathetic) is more irritated than the other, which causes a certain imbalance in this area, as shown for instance by hyperemia. This condition of over-irritation of the autonomic nervous system produces a change in the chemical consistence of the cell surroundings. This has been carefully studied and proved to be true by Zondek and his coworkers. Change in the chemical consistence of the cell surroundings through nerve irritation changes also the previously normal functioning of the cell to pathological function and form. The cell in this stage loses the contact with the nerve as its regulator and grows wild (Marshall, Kimura and Nakamoto). In this stage the histopathological findings are positive, cancer formation sets in (cf. Leitch). If radiation is able to reduce the over-irritated nerve fibers to normal functioning, a normal tissue metabolism should again be established. Through this change of the ions in the intercellular serum, cancer cells would slowly disappear and cells with normal function would be produced. This probably takes place in cases where spontaneous cures of cancer are reported (Ewing). *Prolonged* roentgen treatment finally paralyzes both autonomic nervous systems and this causes an irreparable cell damage. Cancer then grows wild, as mentioned above.

Our efforts should be directed to any kind of investigation which will prove or disprove the foregoing conception. Reviewing the many pharmacologic remedies that are reported from time to time as successfully administered in cancer cases we have found that practically all of them have a certain action on the sympathetic nerves. This is probably true of lead, which has been known since Galen, as a treatment for cancer, and favorable results from its use have lately been reported by W. Blair Bell. Potassium was called in Mancini's[46] time (1869) the best treatment for ulcerated cancer, and Keyser[47] claimed to cure superficial cancer with powdered potassium chloride. Fumagalli[48] proved

histologically that potassium chloride increases granulation. Working on the reports of Zondek,[49] who found that potassium produces an effect identical with that from vagus stimulation, we find that on a granulating wound calcium and potassium show a different effect. To produce granulation a salve of the following consistency has been used in our department for the past year.

Anesthesine	2 per cent
Potassium chlorate	2 per cent
Olive oil	Dram 2
Lanolin Hydr. qsod.	Ounces 2

The granulating effect of this could often be demonstrated, whereas calcium and adrenalin have a quieting effect on cancerous ulcers after a short application. Recently Schück[50] has reported the effect of calcium and potassium on granulations, which confirms our findings and strengthens our opinion that each cell is under a double influence of the autonomic nervous system. Roffo[51] found that the potassium content in the embryo is high and that tumor tissue shows the same high potassium content. Cloves and Friesbie[52] found also an increased potassium content in rapidly growing tumor. As the reports in the literature are contradictory and the chemical methods to determine the amount of potassium uncertain, we are investigating this question again from the standpoint of comparing the potassium and calcium contents in the blood and in the tumor. The results will be published later. We are also studying the inorganic constituents of the serum in cancer in many of our cancer patients (cancer of all locations) and so far have corroborated the figures of Theis and Benedict[53] for normal persons. Similar findings for calcium are also reported by Paolucci.[54] From our observations during the past year we are inclined to believe that the prognosis in cancer is not so good when the percentage of serum potassium is high. If the tumor shrinks after roentgen treatment, the potassium amount in the serum is also reduced.*

If the work of Kraus and Zondek is correct, as it seems to be, we must draw the conclusion that vagus irritation (increase of potassium) plays a certain rôle. We shall try to ascertain in future studies if a sympathetic irritation exists locally in the cancerous part and if generally a vagotonic status as a body defense is present, or vice versa.

The great group of cancer sera which are newly invented every few months belong to foreign protein therapy, and since the work of Petersen, Weichardt, Müller, and Andersen[55] we have reason to think that roentgen rays and nonspecific proteins produce a similar effect. A fact less well known is that insulin also produces some comparable effects.

This leads us to the group of internal gland secretions, with which some good results on cancer are also reported. Stühlern[56] found cessation of cancer growth in some patients after daily insulin administration (10 to 15 units). From insulin we know that a vagus irritating effect must be present, because, for example, the amount of bile after insulin administration is increased. Normal ovarian function increases vagus tonus. In under function or non-function of the ovaries the sympathetic tonus is predominant, and this might be the reason why Foveau de Courmelles[57] again advises in cancer of the breast oöphorectomy or roentgen castration, while English or American surgeons have been able to keep women with inoperable cancer of the breast alive for many years, through ablation of the ovaries. The resulting change in the autonomic nervous system probably causes a retardation of growth, and normal cell functioning follows. Thyroid extract was given by Jones,[58] following which multiple cancer metastasis of the skin disappeared. He cites other cases out of the literature. The effect of thyroid on the autonomic nerves does not need to be discussed. Cholin, 1 part, adrenalin, 2 parts, trypanblue, 5 parts, cerium chloride, 5 parts, is Opitz' new formula for cancer. We know that cholin increases vagus tonus (Le Heux)[59] and that a direct irritating effect of the Auerbach plexus takes place. Schübel[60] and Kylin[61] could prove that adrenalin has an effect on both the sympathetic and parasympathetic

*Details, technique, etc., will be published soon by McClugage and myself.

depending on the condition of the nerves found during injection. Trypanblue and cerium chloride have tumor affinity, and might destroy the wild cells, to allow the new formation of cells to grow normally, after change in the over-irritated nerve has taken place.*

During the last year very important facts about cancer, have been demonstrated through artificial cancer production in animals. Maude Slye was able to prove a strong hereditary tendency to cancer in mice, and familial recessive susceptibility to the development of cancer seems to exist (Warthin[62]). I suggest that Maude Slye, in her wonderful experiments, was able to produce such a high percentage of cancer in her stock of animals, because this strain probably shows alteration of the autonomic nervous system, such as Oswald proved in his thyroid experiments on dogs. He produced hyperthyroidism, but only in dogs which showed alteration of nerve disturbances through inbreeding. If, therefore, any hereditary factor should play a part in the development of cancer it is in my opinion the hereditary factor of autonomic nerve disturbances. Cramer[63] investigated the influence of innervation on the experimental production of skin cancer with tar. He deprived an area of skin in mice of the nerve supply and then painted it twice weekly until cancer supervened. This occurred only after a longer course of time than was necessary in normal animals. Jorstad[64] found that the tar does not act to stimulate growth but to attract cells to it, and away from their blood supply (nerve). He states that "growth is a secondary phenomenon which supervenes only when the cells become sufficiently reduced by a pulling away of the endothelial cells of adjacent capillaries."

The most successful weapons in the fight for cancer today are surgery, roentgen rays and radium. I suggest that surgery is successful only when the over-irritated nerves are also taken away from a wide enough area to allow normal intercellular serum conditions, which ensue later from the normal functioning of the autonomic nerves. The best illustration of this is the radical operation done for cancer of the breast. One may note, too, that radium is effective on primary growth so long as higher situated ganglia are in normal function. Electrocoagulation has a similar effect in those cases, and seems in some conditions superior to radium as it also destroys the inter- and the intracellular ion composition which is pathologically found. Roentgen rays, in addition to radium, correcting the higher ganglia to normal functions again, are always found superior in extensive cancer cases. Even the Curie Institute, Paris, advises this combination treatment.

If Rothmann's[65] experimental work with the ultraviolet rays is right, and Jesionek lends the weight of his authority to it, we have a parallel to the findings in this clinic. Rothmann believes he has proved that a sympathetic paralyzing effect is observed after ultraviolet rays are given. The roentgen-ray effect seems to be the same only in a more lasting degree, and I have always opposed Sampson's[66] ideas on the basis of our experimental work and clinical observations. The excellent work of Pfahler, Klauder and Martin[67] has proved through experiments on rabbits that light and roentgen rays have additional destructive effects.

In the past three years we have built up a technique in cancer treatment which is based on the ideas described above. To destroy much pathological intra- and intercellular ion composition, which produces only pathological cell formation, we use electrocoagulation, and dehydration whereever the tumor can be reached. Locally a roentgen dose is applied, just enough to force the pathological nerve fibers to normal function, and through the direct effect of roentgen rays to destroy the pathological cells. In addition to this we give paravertebral treatment, 6 × 13 cm. field, over the whole area where the paravertebral ganglia are situated, which lead to the diseased part of the body; $^3/_4$ of an erythema dose to each field is sufficient to start with. The clinical symptoms and laboratory findings tell us when to give the next application. Metabolism tests, blood chemistry (principally calcium and potassium tests) are

*This combination of medicaments which Opitz and his coworkers have found through animal experiments (*Klin. Wchnschr.*, IV, No. 23) is from the standpoint of this article, the most reasonable of all cancer sera and medicaments yet brought out.

absolutely necessary, with the right kind of diet and all other clinical aids which can be commanded. Good results in cancer are obtained only by physicians who are entirely familiar with the pathological physiology involved and in clinics equipped with all laboratory facilities.

CONCLUSIONS

1. Roentgen-ray exposure has a depressing effect on the autonomic nervous system if, at the time of treatment, the system is over-irritated.

2. Cell function and growth are probably intimately controlled by the autonomic nervous system.

3. The distance effect of roentgen rays is best explained by its action on the autonomic nerves which are brought to normal function after the roentgen-ray effect has taken place, thus influencing cell metabolism.

4. The term "stimulating dose" in connection with roentgen or radium rays is misleading. The so-called "stimulating effect" is uniformly explained as a depressing effect of actinic energy, affecting the over-irritated part of the autonomic nervous system and bringing the two functions of the autonomic nervous system into balance.

5. The paralyzing effect on the autonomic nervous system through radium and roentgen rays will irreparably deprive the wild-growing cancer cells of their regulator.

6. The puzzling effect of radium and roentgen-ray treatment in cancer, where we often see at first satisfactory reaction of the cancer cells and later wild growth after more treatment, may be explained by the effects exerted by roentgen-ray exposure on the autonomic nervous sytem.

7. The ideal treatment of cancer should take cognizance of these facts and be planned to bring the sympathetic and parasympathetic functions into equilibrium.

8. This conception has given rise, in this clinic, to a revised technique in the roentgen-ray treatment of cancer which is promising. Research along these lines is indicated.

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MEASUREMENT OF THE STRAY RADIATION IN ROENTGEN-RAY CLINICS

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A FEW years ago we constructed an instrument for the measurement of the stray roentgen rays in our laboratory; this instrument which was calibrated in electrostatic units (R), has since that time been used constantly to control the radiation received by the men working in this laboratory and also by the operators in the clinical roentgen departments of the Cleveland Clinic. During the past year or so we have also made measurements in other

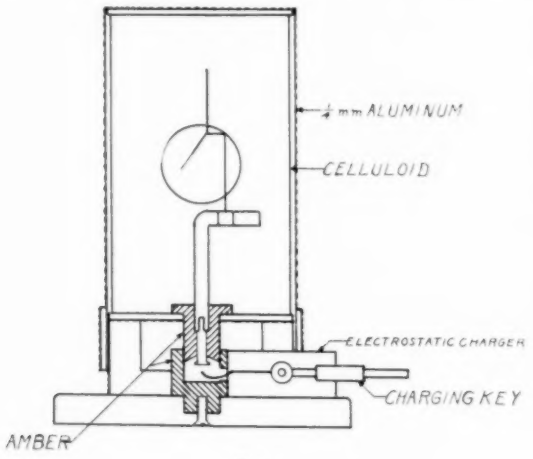

FIG. 1.

roentgen-ray clinics in Cleveland. The following short report of these measurements may perhaps be of interest.

The instrument (Fig. 1) is an electroscope which serves also as an ionization chamber. The interior of the chamber is constructed entirely from organic materials (celluloid walls, graphite filament suspension) and to avoid static disturbances, the whole instrument is surrounded by a thin aluminum cover. The absorption of this and of the different heavier auxiliary parts (lens, lamp, etc.) is of no importance for the accuracy needed. For the purpose of determining the effective wave length of the rays, the instrument can be completely surrounded by a copper housing.

The calibration of the electroscope in electrostatic units (R) is based on a measurement of its capacity C (cm.), volt sensitivity E (volts) and effective volume V (c.c.), the dose per hour being

$$\frac{C \cdot E \cdot 3600}{300 \cdot T \cdot V} \text{ R}$$

in which T is the discharge time in seconds. This method is sufficiently accurate for our purpose, the interior of the electroscope consisting of a material which has very nearly the same effective number as that of atmospheric air. The volume V is 288 c.c., calculated from the dimensions of the electroscope. The sensitivity E, is 30 volts per division. The capacity is 3.4 cm.; this was measured by means of a capacity bridge and for control also by other well-known standard methods for measuring like low capacities.

For the sake of convenience, we shall introduce the unit 1000 R, which we shall designate K-R. (Kilo-Roentgen). One K-R. is approximately the dose necessary to produce a light erythema on the human skin.

Using the values given for C, E and V, we obtain

$$\text{Dose per hour} = \frac{4{\cdot}2}{1000\,T} \text{ K-R.}$$

The calibration of the electroscope was controlled by a radium standard which was placed in a fixed position relative to the electroscope.

In measuring the intensity of the stray radiation during the treatment of a number of patients, the electroscope was placed at the position of the operator and at different heights corresponding respectively to the lower, middle, and upper parts of his body. These different measurements were averaged. For therapeutic plants they are fairly uniform; the upper part of the body usually receiving the largest dose; the difference between the doses amounting to as much as 100 per cent.

TABLE I

INTENSITY OF STRAY RADIATION, THERAPEUTIC MACHINES

Operators	Type of Protection	Conditions of Radiation				Dose per Hour in Per Cents of Kilo-Roentgen (% K-R. hour)	λ_{eff} [Å]	Note
		Type	Kv.	Ma.	Filter			
No. 1	I_1	D	200	4	0.5 mm. Cu	0*		
No. 2	I_1	D	170	4	0.5 mm. Cu	$1.5 \cdot 10^{-1}$%		
No. 3	I_1	D	165	8	0.5 mm. Cu	0*		
No. 4	II_1	D	200	4	0.5 mm. Cu	$1.5 \cdot 10^{-1}$%		
No. 5	I_2	D	200	6	0.5 mm. Cu	$1.5 \cdot 10^{-1}$%	0.28Å	Outside screen [I_2] 0.04% K-R. hour
No. 6	II_2	M	140	6	4 mm. Al	$1.0 \cdot 10^{-2}$%		
			125	5	3 mm. Al	$0.4 \cdot 10^{-2}$%		
No. 1	II_2	M	140	5	4 mm. Al	$0.6 \cdot 10^{-2}$%	0.28Å	
No. 2	II_2	M	125	5	3 mm. Al	$0.6 \cdot 10^{-2}$%	0.36Å	
No. 7	II_3	S	100	2	0	$0.3 \cdot 10^{-2}$%		Outside screen [II_3] 0.03% K-R. hour
No. 8	II_2	S	90	5	2 mm. Al	$0.3 \cdot 10^{-2}$%		

* Less than 10^{-3}%.

In tabulating our results for the therapeutic machines, these have been divided into groups according to the conditions of radiation and the type of protection. As for the conditions of radiation, there are three natural groups, corresponding to potentials of approximately 200, 135 and 95 kv. respectively; these groups are designated respectively as D, M and S; and the corresponding filters are approximately 0.5 mm. Cu, 4 mm. Al and 0.5 mm. Al respectively. The average current is approximately 5 ma.

The different types of protection which are employed may be listed as follows:

I_1: Tube completely enclosed; operator in separate room completely protected from treatment room.

I_2: Tube completely enclosed; operator in treatment room behind protecting screen.

I_3: Tube completely enclosed; operator in treatment room unprotected.

II_1: Tube partly enclosed (lead glass bowl); operator in separate room completely protected from treatment room.

II_2: Tube partly enclosed (lead glass bowl); operator in treatment room behind protecting screen.

II_3: Tube partly enclosed (lead glass bowl); operator in treatment room unprotected.

The results of our measurement are given in Table I. In making such tests one soon realizes the great need for standard specifications for the construction of the different types of treatment rooms which the practice of roentgen therapy demands, in order that in each case the necessary protection may be obtained with a minimum of expense. For instance, in all of the plants of type M, approximately the same amount of stray radiation is present, although the amount of protective material used certainly varies very much. Only a few simple rules would be required in order to make it possible to state for each type of treatment room and for each type of radiation a definite figure for the average intensity of the stray radiation, thus making it possible for the roentgenologist to plan intelligently according to the number of hours per day he expects to spend in the treatment of patients and the type of radiation he expects to use. Even with the present great variation in the designs of treatment rooms, the grouping given above probably covers the majority of cases sufficiently to make it possible to establish a definite figure for the intensity of the stray radiation for each group.

Some of the operators of the therapeutic machines which we have tested also do a certain amount of roentgenoscopic work. On account of the lack of homogeneity in the distribution of the stray radiation, it is a somewhat intricate matter to calculate the average stray dose received in this work. It is very possible also that if determined it would have little significance.

However we shall not here enter upon any discussion of this phase of the problem, since for all the operators (except one whose case will be discussed later) the dose received in roentgenoscopic work is certainly very small as compared with the dose received in therapeutic work. For this reason and because the stray dose received by the operators of the various roentgenoscopic machines varies so greatly, a tabulation of the measurements would seem of little value and we shall therefore give only a statement as to the range of the measured intensities. The dose received at the upper part of the body (in front of the roentgenoscopic screen) varies between 10^{-2} and 10^{-3} per cent K-R. hour, while the dose received over the rest of the body varies from $2 \cdot 10^{-3}$ per cent K-R. hour down to a dose too small to measure (smaller than 10^{-4} per cent K-R. hour). The averages are $0.5 \cdot 10^{-2}$ per cent K-R. hour and 10^{-3} per cent K-R. hour respectively. With one exception, all the operators wore a lead rubber apron when doing roentgenoscopic work and this was placed in front of the electroscope when the measurements were made. It may be of interest to mention that while the best of the lead rubber aprons which we have tested decrease the stray radiation to a few per cent of its value, we have found that some of them decrease the intensity to only 25 per cent of its value. A similar range is found for the lead glass screens.

All the operators had been working for at least one year under the conditions tested and the doses received per year by each are given in Table II.

TABLE II

YEARLY STRAY RADIATION DOSE RECEIVED BY OPERATORS OF THERAPEUTIC MACHINES

Operator	Type of Radiation	Dose per Year in Per Cents of Kilo-Roentgen (% K-R. hour)
1	M	2.4%
2	M	0.25%
4	F	0.6%
5	D	1.5%
6	M	1.0%
7	S	0.5%

The operator designated as No. 6 in Table II does roentgenoscopic work only. He does not wear an apron and the stray radiation intensity is quite uniform over his whole body, being about 0.5 per cent K-R. hour.

A blood examination of the operators revealed nothing of interest and the recorded doses are probably to be regarded as not exceeding the amount of radiation that can be received without any serious consequences.

MEASUREMENT OF STRAY RADIATION IN ROENTGEN-RAY CLINICS OF NEW YORK CITY

BY LILLIAN E. JACOBSON

NEW YORK CITY

AT the suggestion of Dr. Fricke, I have measured the stray radiation from therapeutic machines in several hospitals of New York City.

The electroscope used for this purpose is the same as used by Dr. Fricke and described in a report in this Journal.*

In the table which follows the same symbols are used as those employed by Dr. Fricke.

The following is an explanation of the symbols for the type of protection:

I_1 The tube is completely enclosed and the operator is in a separate room completely protected from the treatment room.

II_1 The tube is partly enclosed (lead glass bowl) and the operator is in a separate room completely protected from the treatment room.

II_2 The tube is partly enclosed (lead glass bowl) and the operator is in the treatment room behind a protecting screen.

It will be seen that the measurements are in a good general agreement with those of Dr. Fricke.

TABLE I

Clinic	Operator	Type of Protection	Conditions of Radiation				Dose per Hour % Kilo-Roentgen	Note
			Type	Kv.	Ma.	Filter		
1	1	I_1	D	200	3.5	0.75 mm. Cu 1 mm. Al	3.9×10^{-4}	1
1	1	I_1	D	200	3.5	0.75 mm. Cu 1 mm. Al	0	
2	2	I_1	D	200	5	0.5 mm. Cu 1 mm. Al	1.4×10^{-4}	
3	3	I_1	D	180	4	0.5 mm. Cu 1 mm. Al	0.7×10^{-4}	
4	4	II_1	D	200	4	1 mm. Cu 0.5 mm. Al	0	2
2	2	II_1	D	200	5	2 mm. Cu 1 mm. Al	0.7×10^{-4}	
5	5	II_1	D	190	4	0.5 mm. Cu 1 mm. Al	6.3×10^{-4}	3
5	6	II_1	D	190	4	0.5 mm. Cu 1 mm. Al	5×10^{-4}	
1	1	II_1	M	135	5	0.25 mm. Cu 1 mm. Al	1.8×10^{-4}	
5	6	II_2	M	120	5	3 mm. Al	0.9×10^{-2}	

Notes: 1. 8.5×10^{-4} per cent through the lead glass window.
2. Top of tube covered with lead glass and a very thick lead glass window used.
3. Large amount of stray radiation through large lead glass window.

TABLE II

Operator	Type	Dose per Year (% Kilo-Roentgen)
1	D	0.2%
5	D	0.6%
6	D and M	1.9%

Note: The others had less than 0.1 %

* See page 146.

THE CAUSES OF THE DESTRUCTION OF CHOLESTEROL IN VITRO BY ROENTGEN IRRADIATION

BY R. P. MACFATE AND A. BACHE

From the Research Laboratories of the College of Medicine, University of Illinois

CHICAGO, ILLINOIS

IN several publications Roffo and Correa describe the results of the roentgen irradiation of cholesterol *in vivo* and *in vitro*. The authors noted and measured quantitatively a destruction of cholesterol *in vivo* and *in vitro*. In the latter case the cholesterol was dissolved in chloroform and in benzine (petroleum ether). Crystallized cholesterol was not affected by the rays. The energy applied cannot be estimated exactly, as the milliamperage is not given. The authors come to the conclusion that roentgen rays produce a direct effect upon the cholesterol molecule, and that this effect is a process of oxidation, as shown by the increase in per cent of oxygen present after irradiation.

The existence of such an effect would be of immense value for comparative measurements of roentgen-ray doses with the point in view of closest comparison with the biologic specimen. Cholesterol contains only the elements carbon, hydrogen, and oxygen, which are the main constituents of all organisms. Further, it can be dissolved in a fluid (alcohol) or a mixture of fluids which has the same specific weight as the average biologic tissue (1.00). No substance with these properties is known or used for roentgen-ray measurements at the present time. Air is used in the ionization method, but it has too low a specific weight and there exists no comparison with biologic tissue as far as absorption (and scattering) is concerned. The other methods use high-atomic elements, such as selenium, silver, bromine, platinum, mercury, etc., each having a characteristic spectrum of absorption and emission, which is totally different from that of biologic tissue. Thus, an error of hardness comes in, which excludes the above method from being used for comparison of various qualities of roentgen rays.

Due to the importance of the reaction mentioned, we have exposed cholesterol solutions to roentgen rays. In most of the experiments, the concentration of cholesterol was 0.02 per cent. The following solvents were used: chloroform; carbon tetrachloride; benzine (petroleum ether); benzole; toluol; absolute ethyl alcohol; acetone; ethyl butyrate; and carbon bisulfide. The following were the conditions of exposure: 170 kv.; 20 ma.; 12 inch distance; one black paper as light filter; 20 minutes' exposure; reducing 12,000 R (8000 German R), corresponding to about 30 erythema doses.

The Liebermann reaction showed that only with chloroform and with carbon tetrachloride a marked destruction of cholesterol resulted—44, 41 and 45 per cent in the case of chloroform, and 70 per cent in the case of carbon tetrachloride. All other solutions were not affected at all. This was especially striking in the case of benzine as solvent, as Roffo and Correa describe the same reaction in benzine as in chloroform. In order to clear this point, benzine from various companies, and benzole were used, all with the same negative result (with one exception to be mentioned later). Mixtures of chloroform and benzine were used, with the result that two drops of benzine (1.0 per cent) in the chloroform solution reduced the destruction from 44 and 45 per cent to 29 per cent. Ten per cent benzine reduced the destruction to 4 per cent, and with more than 50 per cent benzine, no destruction resulted at all.

From these experiments we came to the conclusion that the destruction of cholesterol is not a direct effect of the roentgen irradiation, but seems rather to be produced by an effect upon chloroform and carbon tetrachloride.

It is well known that chloroform is a very unstable substance, decomposing slowly in direct sunlight, and combining with atmospheric oxygen according to the following equations:

$$4CHCl_3 + 3O_2 \rightarrow 4COCl_2 + 2H_2O + 2Cl_2$$
$$2COCl_2 + 2H_2O \rightarrow 2CO_2 + 4HCl$$
$$2CHCl_3 + 2Cl_2 \rightarrow 2CCl_4 + 2HCl$$
$$\overline{6CHCl_3 + 3O_2 \rightarrow 2COCl_2 + 2CCl_4 + 2CO_2 + 6HCl}$$

With this in mind, we examined a saturated solution of chloroform in distilled water, together with pure chloroform and pure carbon tetrachloride, for acidity, oxidizing power, and presence of chlorine, before and after irradiation. The acidity was determined by the use of hundredth normal sodium hydroxide, using methyl red as indicator. The oxidizing power was determined by the use of hundredth normal ferrous ammonium sulphate, titrating the excess with hundredth normal potassium permanganate. A microburette was used and all titrations were made under exactly similar conditions. Free chlorine was tested for by the use of iodo-starch paper.

With the saturated water solution of chloroform, no appreciable changes were noted, although a slight increase in acidity was found. The solution was too dilute to show any marked effect.

With the pure chloroform, a distinct increase in both acidity and oxidizing power was noted. The same was found in the case of carbon tetrachloride. No test could be obtained for free chlorine.

This increase in activity on the part of the chloroform is therefore concluded to be the cause of the destruction of the cholesterol. In the case of benzine and chloroform mixtures, the action is possibly transferred to the benzine, which is less stable than cholesterol, and less or no destruction of the latter takes place.

In the case of our first two measurements on benzine, an inferior grade was used. In these cases slight destruction occurred. Upon using c. p. benzine, however, no action was found to have occurred. The destruction obtained must have been due to some impurities present in the benzine. This is a possible explanation for Roffo and Correa's positive results. In one exposure using ethyl butyrate we found slight destruction, while later experiments gave no further results. Here again the destruction must have been due to some impurity present in the solution.

We next exposed pure chloroform to roentgen rays, and after exposure added a chloroform solution of cholesterol. Slight destruction was noted to have taken place. This leads to the conclusion that the oxidizing power is probably in a nascent condition, although some of this power will remain, the amount depending on the time of original exposure and upon the lapse of time before addition of the cholesterol.

Our next experiment was to determine what chemical compound of chlorine caused the destruction of cholesterol. The following substances were added to chloroform solutions of cholesterol: hypochlorous acid; chloric acid; perchloric acid; chlorine (gas); and a 20 per cent solution of phosgene in toluol. The solutions were then evaporated to dryness to expel all water. At complete dryness, the residue was redissolved in chloroform, made up to volume, and the Liebermann reaction executed. Complete destruction was noted in all cases but that of phosgene, where only slight destruction occurred.

SUMMARY

Roentgen irradiation of cholesterol in different solvents shows destruction only with chloroform and carbon tetrachloride. Chloroform and carbon tetrachloride show increased acidity and oxidizing power upon exposure to roentgen rays. The oxy-acids of chlorine, together with chlorine itself, cause the destruction of cholesterol. Chlorine is eliminated by negative tests for its presence. Hence, the original destruction is due to the probable formation of some oxy-acids of chlorine, strongest in their nascent condition, formed by the breaking down of chloroform upon irradiation.

CONCLUSIONS

(1) Cholesterol is destroyed by roentgen irradiation only in chloroform and carbon tetrachloride solutions.

(2) The effect is an indirect action, due to the formation of oxidizing substances, probably the oxy-acids of chlorine.

(3) The reaction is not useful for roentgen-ray measurements which need exclusion of the error of hardness.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Publishers: PAUL B. HOEBER, INC., NEW YORK

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application. Editorial office, 1909 Massachusetts Ave., N.W., Washington, D.C. Office of publication, 76 Fifth Avenue, New York.

Information of interest to all readers will be found on page ii.

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EDITORIALS

COSMOPOLITAN MONTREAL

A CITY of striking and sometimes startling contrasts, of vivid lights and shades; a city whose name breathes the spirit of romance and the genius of history; a city of a storied past, a present of marvelous achievement and an illimitable future; a city where the handiwork of men who lived and toiled three hundred years ago still stands side by side with products of modern engineering and constructive skill; a city where an amalgam of British and French stocks with an alloy of other races has produced a population unique in its distinctiveness and an atmosphere not to be duplicated elsewhere in the New World—such a city is Montreal, which stands ready to greet its guests and provide them with unforgettable experiences that will lure them back again. Here, more than one thousand miles from the ocean, is one of the world's greatest seaports. Here is a city of huge transportation interest, the headquarters of the world's two largest railway systems; of industries which dominate the whole Canadian field; of concerns which control the financial destinies of the Dominion; of educational institutions made famous throughout the world by the towering intellect and brilliant discoveries of their faculty members or graduates; a city whose public-spirited citizens have made it a center of art and philanthropy and civic beauty.

But it is not these things which put Montreal in a place by itself and give it a character and a personality unmatchable in the Western Hemisphere, for other cities can show similar triumphs of modernity. It is the blending of old and new, the juxtaposition of the ancient with the present, that link it with the annals of the ages, and constitute its chief charm. Here the visitor may turn from broad avenues lined with palatial buildings, or thoroughfares bustling with all the activities of a mighty metropolis, and find himself in a network of narrow crooked streets whose very stones are redolent of high adventure. For it was from these same streets, and from their quaint stone buildings of the seventeenth and eighteenth centuries, that the men who carried civilization and religion and enlightenment over half the Continent took their departure. Taking their farewell of what rude comfort the frontier settlement offered, they plunged into the wilds—one the first white man to traverse the Great Lakes, another the first to penetrate to their headwaters, a third to discover the Mississippi River and descend it almost to its mouth; others to carry the gospel to the savagas and to die as martyrs at their hands; still others to found the cities—Detroit, Marquette, Duluth and Joliette—which perpetuate their names or the language of these hardy pioneers.

Here was the starting place of military expeditions which, after winning the wilderness from its pagan possessors, carried on the long struggle for supremacy between the French makers of Canada and the English settlers of the Thirteen Colonies; hither came the envoys of the Continental Congress, seeking the adhesion of Canada to the Republic soon to be born, and, their mission having failed here followed them the troops of the Revolutionary army, hoping to gain by conquest where diplomacy could not win, and hence they came, some to defeat and death, some to victory and honor. There is hardly a foot of Old Montreal that has not its memory of the heroic men of the three peoples—French, British and American—the forerunners and the founders of the two great nations which now divide nearly all the Continent of North American between them.

Nor are structures two or three hundred years old, and thronging memories of their first occupants, Montreal's only link with the past. Within an hour's run of the city on any side the visitor finds himself in a

different and an older world. Stone or plastered cottages which recall the Breton countryside, thatched barns, and wayside shrines which speak eloquently of an unspoiled and implicit religious faith, prepare the stranger for his first acquaintance with the habitant, the French-Canadian farmer, who, in his wholesome outlook on life, his shrewd and kindly disposition, his devotion to the soil and his homely virtues, is but little changed from his sturdy forebears who came to the Canada which King Louis loftily but ignorantly described as "a few acres of snow." There is an Old World flavor about rural Quebec which is a delight and a revelation to the sojourner from other parts of the world.

Montreal's key position, from a transportation standpoint, gives it enviable advantages as a convention point or an objective for touring. It is on the main line of both of Canada's great transcontinental systems. It is the head of ocean navigation during a season which extends from April to December, and it is midway on the fine steamer services which ply from the head of the Great Lakes to the Gulf of St. Lawrence. It is the hub of a network of modern highways connecting it with the Adirondacks, New York and the New England States on the south, Ontario on the west and the Maritime Provinces of Canada on the east. Highway and railway facilities offer a wide variety of half-day or one-day trips. The Laurentian Mountains, a paradise of peaks, lakes and rivers, with incomparable scenic beauties, a full variety of summer and winter sports, and unsurpassed hunting and fishing, are reached within two or three hours by train or motor.

The visitor to Montreal finds himself in an atmosphere where is preserved the old-time British and American traditions of personal liberty. Crossing the border involves no irksome or annoying experiences for the bona fide tourist or convention delegate, no passports are required, and the customs and immigration formalities are quickly and easily carried through. Such provincial enactments as affect the traveller for recreation, as the motor vehicle law and the fish and game regulations, have been conceived in a liberal spirit designed to promote the convenience of the public, whether resident or transient, and are entrusted to courteous and efficient officials.

THE MONTREAL MEETING

Arrangements are complete for the meeting of the American Roentgen Ray Society in Montreal, September 20 to 23. There was some misgiving at one time because of the recent epidemic of typhoid fever in Montreal but the Executive Council of the Society has kept in close touch with the situation and now has no hesitancy in inviting members and friends to attend the meeting. The epidemic, which was one of the largest ever recorded anywhere, was traced to the milk supply of a single company. The situation was under control by the first of July and since that time there has been no milk-borne typhoid in Montreal. Since early in July the reports of the health authorities have shown that the comparatively few new cases are contact cases occurring for the most part in the families of those who had typhoid during the epidemic.

The following telegram was received from Dr. Pirie on August 16th:

"Latest returns to date of typhoid in Montreal for the last week are as follows: Ninth August three cases, tenth August four cases, eleventh August three cases, twelfth August none, thirteenth August one, fourteenth August none, fifteenth August one. These figures received this fifteenth day of August at four-fifty P.M., from Medical Officer of Health show how little typhoid there is in Montreal."

The above report is typical of those received since early in July and since Montreal has a population of about a million people the number of cases reported is not large.

There is bound to be, of course, a considerable number of typhoid carriers in a population in which there has been approximately 5000 cases of typhoid, and for that reason it cannot be stated that Montreal is as safe as any city, but with ordinary precautions it is believed that any person attending the meeting will be safe from infection. A considerable per-

centage of members of the medical profession are now immunized against typhoid by virtue of having taken the prophylactic injections; some have taken them on two or more occasions and may consider themselves quite immune. Since the value of the prophylactic vaccine has been so thoroughly established it is a precaution that no one can afford to neglect especially before travelling or going to vacation resorts. It will be an additional and advisable precaution for those going to the Montreal meeting which will render them as safe as they would be anywhere.

Dr. Pirie has provided a most attractive program for the meeting this year and every effort is being made to render the meeting interesting and to provide for the entertainment and comfort of all who attend. The summer tourist rates to Montreal will still be in effect at the time of the meeting. It is hoped that misgivings with regard to the epidemic will not prevent a large number of our members and friends from attending.

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this column solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Charles L. Martin, Dallas, Texas.
Twenty-eighth annual meeting, Montreal, Can., Sept. 20–23, 1927.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Fred M. Hodges, 801 West Grace St., Richmond, Va.
Annual meeting, Minneapolis, Minn., 1928.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. Robert J. May, St. Luke's Hospital, Cleveland, Ohio.
Annual meeting, New Orleans, La., Nov. 28–Dec. 2, 1927.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. E. C. Samuel, New Orleans, La.
Annual meeting, Memphis, Tenn., Nov. 14–17, 1927.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. R. A. Arens, Michael Reese Hospital
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. James H. West, 8314 Euclid Ave.
Meetings are held at 6 o'clock at the University Club, on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. Henry L. Ulbrich, 1130 E. Grand Blvd.
Meets monthly on second Friday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. M. C. Sosman, Peter Bent Brigham Hospital, Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. W. W. Belden, 8 West 16th St.
Meets monthly on second Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

ROENTGEN RAY SOCIETY OF CENTRAL PENNSYLVANIA
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Eugene Pendergrass, University of Pennsylvania, Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. S. C. Davidson, Highland Hospital.
Meets monthly on the first Friday evening at 7.45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Metropolitan Building.
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. Davis Spangler, Dallas, Texas.
Meets annually.

BRITISH EMPIRE

BRITISH RÖNTGEN SOCIETY
Meets on the first Tuesday of each month from November to June inclusive, at 8.15 P.M., at the British Institute of Radiology, 32 Welbeck St., London, W. 1.

BRITISH INSTITUTE OF RADIOLOGY
Secretary, Dr. John Muir, 32 Welbeck St., London, W. 1.
Meets at 32 Welbeck St., but regular dates and times of meeting have not yet been arranged.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8.30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

RADIOLOGICAL SECTION, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. C. A. Anderson, The Hospital, Dunedin.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

CANADIAN RADIOLOGICAL SOCIETY
Secretary, Dr. E. C. Brooks, Montreal.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

* Secretaries of societies not here listed are requested to send the necessary information to the editor.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.
Next meeting with the Gesellschaft deutscher Naturforscher und Aerzte will be in Hamburg, September, 1928.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.
Next meeting September 27, 1928, in Hamburg.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs S. A. Reinberg and S. G. Simonson.
Meets annually.
Fifth Annual Meeting in Kiev, Ukraine, May, 1928.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. H. Scheuermann, Copenhagen
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

VIENNA LETTER

LATE ROENTGEN ULCERS

Professor Béla Kelen is of the opinion that so-called early injuries after application of roentgen radiation are due to faulty dosage and never to idiosyncrasy, because up to the present time no one has succeeded in proving the existence of a decided idiosyncrasy. He himself applied irradiations in well over 40,000 instances. He failed to meet with this in a single case. Late ulcers which occur after a considerable time could not be explained. Histological examinations showed that irradiations repeated several times may be followed by irreparable injury of the endothelium of the capillaries and also by the obliteration of the small blood vessels. Telangiectases develop which can also be seen macroscopically in the origin of which an important rôle is played by the poor nutrition of the skin, associated also with exaggerated sensitivity of the epidermis to external influences so that relatively unimportant stimuli, such as scratching, pressure, etc., may bring about inflammations and ulcers. The only radical treatment of ulcers is excision. Out of 290 cases in which erythema doses were employed in a primitive way without the use of filters late ulcers occurred in only 3 cases. By hearsay he has knowledge of only 2 other cases, a total incidence of 1.72 per cent. In the period of aluminum filters out of 2,950 patients, 8 have developed late ulcers, an incidence of 0.27 per cent. Since the advent of modern roentgen apparatus with high voltage transformers, zinc filters, Coolidge tubes, and exact dosimeters, he has given during the past six years 1684 treatments without a single injury. He had under his care 13 late injuries in patients who were treated by other roentgenologists.

From these facts we may conclude that late roentgen ulcers are not caused by the direct action of the roentgen rays but that

they evolve from telangiectases with the addition of smaller or greater traumas. Late injuries can be obviated by applying exact doses and by observing the following rules: (1) a complete erythema dose should not be given; (2) a surface which has once been erythematous should not be irradiated again; (3) telangiectatic areas should not be irradiated at all; (4) the intervals beween applications must be so chosen that a cumulative effect will not be obtained. By employing high voltage and giving suberythematous doses we may rest assured that no late injuries will occur. A fresh irradiation cycle should not be begun until a minimal six months' interval.

THE ROENTGEN DIAGNOSIS OF DISEASES OF THE UTERUS AND ADNEXA (HYSTEROSALPINGOGRAPHY)

Dr. Nicholas Temesváry has devised an instrument which is serviceable in roentgen examination of the uterus and its adnexa. He has used this instrument in a fairly large number of cases in Breslau at the gynecological clinic of Professor Asch in the Allerheiligen Spital. He looks upon lipiodol as the best contrast material. Its injection must be performed under the strictest possible precautions, including preliminary bacteriological examination of the discharge, particularly for gonococci, the evacuation of the bladder and rectum, observation of the rules of asepsis, etc. The injections are made very slowly under minimal pressure. The method is contraindicated in cases of acute and subacute inflammations of the uterus and its appendages, cancer and pregnancy. In the latter condition the danger lies not only in the eventual interruption of gestation but also in the liability of injury to the fetus. It is a bit contradictory to this that some authors recommend this method for the diagnosis of pregnancy. Temesváry considers the method as valuable for determination of the permeability of the tubes and considers it superior to Rubin's method because it enables one to find the location of the obstruction, and it is also less inconvenient and dangerous. The method is further indicated in cases of myomas and particularly for the differentiation of the submucous tumors from the interstitial ones, which is very important with many operators from the point of view of choosing between roentgen treatment and operation. It is further of value for differentiation of adnexal tumors from uterine and ovarian tumors, and finally for the diagnosis of certain abnormalities such as uterus bicornis. The method also proved to be useful in the domain of the physiology and anatomy of the internal genitals because with its aid the existence of a sphincter in the intramural part of the tube can be determined and also the peristaltic movement of the tubes, the partial and total contractions of the uterus, and finally the extraordinary stretching and extension of the tubes in consequence of the loss of their muscular tone may be observed in pathological cases. Temesváry believes that hysterosalpingography is a simple and danger-free method and a valuable addition to our gynecological procedures.

A CASE OF CATARACT CAUSED BY ELECTRIC CURRENT

Dr. Pelláthy, clinical assistant in Budapest, exhibited before the Budapest Medical Society a case of cataract caused by electric current. The patient, a woman of thirty-one came into contact with an uninsulated wire carrying 330 volts. She sustained some injuries which healed in about four weeks. Two months subsequent to the accident she noticed that her sight was impaired. An eye specialist diagnosed double cataract. It is a very uncommon occurrence that such a relatively low voltage should cause an opacity of the lens. In most cases, said Pelláthy, such opacities are due to the action of currents above 500 volts. One case is described by Franklin in which a current of still lower voltage —220 volts A.C.—caused similar pathological changes. In his case, according to Pelláthy, the strength of the current did not play the deciding rôle in the development of the cataracts. They were rather attributable to the site of the injury, one pole of the current having acted on the head of the patient and the other on her left hand. In such cases no part is played by the thermic or mechanical action of the rays but the chief cause in bringing

about the opacity of the lense is the catalytic action of the current.

THE SURGICAL EXPLANATION OF THE SO-CALLED DIVERTICULUM OF THE GALL-BLADDER

Dr. Stephan Cukor read a paper before the Hungarian Roentgen Society on the above subject. He related a case of a patient aged forty-one who was admitted to the clinic of Professor Hültl with gastric complaints. Cholecystography showed a protuberance on the right half of the fundus of the gall-bladder which was regarded as a diverticulum of the gall-bladder. The patient was operated upon, chronic appendicitis found and the vermiform appendix removed. A cone-like protuberance was seen on the fundus of the gall-bladder bent slightly toward the right. Between the protuberance and the body of the bladder there was a ring-like contraction seen on the musculature of the bladder reminding one of a sphincter. This contraction ceased before the eyes of the spectators and the diverticulum disappeared. On irritation of the gall-bladder the contraction and the diverticulum reappeared. There was no stone in the gall-bladder and its contents could be easily evacuated.

The explanation of the findings seems to be as follows: The operation left no doubt of the existence of a long-standing appendicitis and it is quite certain that the patient's complaints were caused by this. The gall-bladder was quite normal aside from the pseudo-diverticulum. It is very likely that this "peristalsis" which disappears before the eyes of the observers is a new proof of the active function of the wall of the gall-bladder.

To the Editor:

The article, "Os Vesalianum Pedis" by G. G. Davis in the Journal for May, 1927 (Vol. XVII, page 551) creates such an erroneous impression of the rarity of a fairly constant normal finding that it seems wise to call attention to it. The small bony nucleus demonstrated by the author is clearly the epiphysis of the tuberosity of the fifth metatarsal. This appears during the thirteenth year of life and becomes united with the shaft of the metatarsal during the fifteenth year. It can be seen quite constantly during this period. Any roentgenologist of experience will recall seeing this shadow as frequently as is consistent with the short period of life during which it is present. The os vesalianum pedis, on the other hand, is exceedingly rare. It is a rather square shaped nucleus and appears proximal to the fifth metatarsal rather than posterior to it and is essentially a part of the tarsus rather than of the metatarsus. The nucleus described by the author is obviously a part of the cartilaginous development of the metatarsal portion of the foot. A complete description of the differences between the two bones and a review of the literature can be found in Köhler's "Grenzgebiete der Normale und Anfang der Pathologisch im Röntgenbild" (4th edition, page 88).

LEO G. RIGLER, M.D.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

DIE RÖNTGENTHERAPIE DES CHIRURGEN. (SURGEON'S HANDBOOK OF ROENTGENOTHERAPY.) By Hans Rahm, Privatdozent der Chirurgie an der Universitat Breslau. Paper, price, 48 marks; bound, Price, 50.50 Marks. Pp. 547, with 205 illustrations. Stuttgart: Ferdinand Enke, 1927.

This book, constituting the 37th volume of Neue Deutsche Chirurgie, is a very interesting and valuable volume. The author is himself a surgeon who has for a number of years occupied himself with roentgen therapy and its physical bases, and he knows how to make what might otherwise be considered dry material very interesting and understandable. In his dual capacity as surgeon and roentgenologist, the author expresses his belief that he can handle the subject better than a pure roentgenologist or a pure surgeon, and determine better where lie the boundaries between cases which should be treated by radiation and those which should be treated by surgery. It is self evident that these borderlines cannot be too sharply defined. In his work, the author draws frequently upon the material of the Breslau Surgical Clinic and material from his own clinical work, and the opinions expressed in the book are stated to be not only those of the author, but of various other investigators whose work is frequently cited. The book is offered as a complete work including suggestions on physics, technique, methods and the biological and clinical aspects of deep roentgen therapy; and it constitutes an excellent guide, both for the surgeon and for the roentgenologist, without being too full of details. The average physician would prefer to spend his energies on the clinical rather than on the physical side of deep roentgen therapy. This book endeavors to simplify physics, a knowledge of which is necessary in deep roentgen therapy. There are chapters on the applications of deep roentgen rays as a therapeutic means in orthopedics, gynecology and urology.

JAMES T. CASE.

APPLIED X-RAYS. By George L. Clark, Ph.D., Assistant Professor of Applied Chemical Research, Massachusetts Institute of Technology. Cloth. Price, $4.00. Pp. 255, with 90 illustrations. New York: McGraw-Hill Book Co., Inc., 1927.

The title implies the use of roentgen rays from a practical and scientific standpoint as well as their value in medicine. The text is written by a physicist and a mathematician and deals with the subject from that vantage point. In general, it is beyond the grasp of any except those who have specialized in physics. The contents are divided into three parts. The first part deals with the fundamentals of roentgen rays. The high tension equipment used in the experimental work is described and illustrated. The subjects covered include the properties of roentgen rays, their absorption, wave length, qualities, scattering, the roentgen-ray spectra and their relationship to atomic structure.

The roentgenologist and roentgen therapist will find a valuable source of information in part two which deals with the "Direct Effects and Applications of X-Radiation." The attitude of the medical profession in regard to radiation is aptly expressed by a quotation from Ewing that "the ultimate knowledge of the mode of action of radiation still eludes our grasp," also that "greater effectiveness in treatment will come only with adequate scientific knowledge and with skilled measurements of dosage in terms of *x*-ray spectra, the laws of absorption and established ionization phenomena."

Roentgenology in relation to medical diagnosis is very briefly considered. One of the most interesting portions of the book is that dealing with roentgen rays in industrial diagnosis.

The third part includes more than two-thirds of the text and is taken up with the "X-Ray Analysis of the Ultimate Structure of Materials." This necessarily is mainly a mathematical treatment and is of value to those interested in crystallography, chemistry and metallurgy.

The book is highly recommended because of its thoroughness of treatment, comprehensiveness and clearness of statement.

F. O. COE.

BOOKS RECEIVED

X-RAYS AND ELECTRONS: AN OUTLINE OF RECENT X-RAY THEORY. By Arthur H. Compton, Ph.D., Professor of Physics in the University of Chicago. Cloth. Pp. 403, with 132 illustrations. New York: D. Van Nostrand Co., 1926.

Clinical Application of Sunlight and Artificial Radiation. By Edgar Mayer, M. D. Cloth. Price, $10.00. Pp. 468, with 37 plates, and 16 figures in the text. Baltimore: The Williams and Wilkins Co., 1926.

The Normal Chest of the Adult and the Child. By J. A. Myers, Associate Professor of Preventive Medicine, Medical and Graduate Schools, University of Minnesota; Medical Director, Lymanhurst School for Tuberculous Children, Minneapolis, Minnesota. Cloth. Price, $5.00. Pp. 419, with 141 illustrations. Baltimore: The Williams and Wilkins Co., 1927.

Radiotherapie. By Docteur W. Vignal, Electro-radiologiste des Hôpitaux. Paper. Price, 25 fr. Pp. 424, with 67 illustrations. Paris: Gaston Doin & Cie, 1927.

INTERNATIONAL ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

ARNOLD, WILHELM. A calcified pleural induration. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 958–960.

A report is given of a case in a workman forty-two years old. The roentgenogram showed an extensive calcification of a pleural induration which was due to an exudative pleuritis occurring twenty years previously. In this case the whole left lung showed a decreased radiolucency, the lung field reduced in size and the intercostal spaces very much narrowed. In the lower left lung field there was a structure, larger than a saucer, consisting of numerous closely packed specks of calcium density, combining to produce a tumor-like shadow and which from the roentgenoscopic examination surrounded the lung like a sheath. The outline of this structure was found to be absolutely sharp on all sides.

BALENSWEIG, IRWIN. Unusual vertebral injuries. *Arch. Surg.*, January (Part I), 1927, xiv, 29–45.

The early recognition of a fracture or fracture dislocation of the spine should not be difficult in the light of our present clinical and roentgenological knowledge. The average physician probably feels that a person who is not paralyzed and who has not fallen from a considerable height is merely suffering from a strain of the back. The failure to request lateral views of the site of injury in addition to the anteroposterior roentgenograms is to be condemned. The former are of far greater diagnostic value. In addition, the orthopedic surgeon is consulted late in the course of the condition, during which time the injured person has developed an anxiety neurosis in addition to the already existing physical symptoms. This is hard to combat and the treatment and disability are therefore unnecessarily prolonged. The injuries are rarely due to direct violence, usually to indirect violence. The fractures of the spine usually involve a single vertebral body. The site of election is the dorsolumbar segment extending from the 11th dorsal to the 3d lumbar level. The first lumbar vertebra is the one most frequently affected. Fracture dislocations occur more frequently in the upper cervical and lower lumbar regions or in the locations that are most mobile.

Whenever possible, at least two views of the spine should be shown. A proper interpretation of the roentgenogram should include: (1) contour: angulation, lateral deviation and rotation; (2) shape of the vertebral bodies: compression, wedging and fragmentation; (3) intervertebral spaces: narrowed; irregular; (4) articular facets and their relationships to one another; (5) fracture of laminae; (6) fractures of transverse processes; (7) fracture of spinous processes and their relationship to one another (may be overlapped in dislocations); (8) productive changes denoting evidences of healing.

Reports are given of 8 cases presenting various unusual aspects.

BALLON, DAVID H., and BALLON, HARRY C. Pneumonography with iodized oil, 40 per cent, by the bronchoscopic method. *Arch. Surg.*, January (Part II), 1927, xiv, 184–202.

This is a study of the bronchial tree with observations made from 100 injections. In the living subject the bronchial tree was injected with iodized oil, 40 per cent, by the bronchoscopic method; and in post mortem specimens it was injected with paraffin. The relation of the circulatory system to the bronchial tree was studied by injections of barium sulphate in gelatin into the blood vessels. At various age periods the appearance of the normal bronchial tree after injection of the iodized oil appears to be constant. Abnormalities of the bronchial tree are frequent in chronic fibroid phthisis, diseases of the pleura and mediastinum and in bronchiectasis. Bronchial stenosis is often found to be associated with bronchiectasis or pulmonary abscess.

The branched intrapulmonary bronchi and bronchioles are the most frequent sites of bronchiectasis, putrid bronchitis, bronchiolitis and bronchiolectasis. The bronchial tree after extrapleural thoracoplasty for tuberculosis may undergo numerous changes, and become a large tube associated with localized or generalized bronchiectasis at the base. When the bronchiectasis extends to the periphery, methods of collapse should give better results than when the dilatations are basal. Iodized oil by the bronchoscopic method is an aid and a guide in the selection of suitable cases for the thoracic surgeon, and in the prognosis and treatment. It becomes possible to treat each case individually and increases the good results obtained by postural drainage.

Ordinary roentgenograms of the bronchial tree are unsatisfactory and often confusing owing to the fact that the bronchial tree divides frequently and is repeatedly crossed by part of the pulmonary circulation. It fails to give any information as to the site and extent of the disease. The importance of the accurate interpretation of roentgenograms made following the injection of iodized oil must be emphasized. A positive shadow cast by an injection which cannot be adequately explained on the basis of clinical history, signs, symptoms and a bronchoscopic examination should not be considered. A typical shadow when substantiated by a clinical picture allows of no discussion.

BENDOVE, RAPHAEL A. Roentgenology as an investigational field in the mechanism and diagnostic significance of physical signs of the chest. *Am. J. M. Sc.*, March, 192-, clxxiii, 322–332.

Roentgenology can be used to great advantage in the investigation of the mechanism of physical signs of the chest and in evaluating their diagnostic and prognostic significance. The application of this investigational method to the study of the physical signs of pulmonary cavities, pneumothorax, certain râles, etc., has gradually assisted in elucidating the mechanism of many of these signs and brought about a revision in their diagnostic interpretation.

About 50 per cent of the pulmonary cavities are silent as to the classical signs of cavitation; of these few are absolutely mute, but most of them can be detected by groups of signs such as modified breath sounds with moist inspiratory râles heard over an isolated area of the lungs. The presence of amphoric breathing indicates a pleural-visceral opening. As soon as the opening closes the amphoric breathing disappears and the lung begins to re-expand, as can be watched roentgenoscopically. The varying physical signs of pneumothorax in the same side of the chest are determined by the modified pneumodynamics and the localization of gas in the involved pleural cavity.

Subcrepitant crackling râles heard over an area on deep inspiration are due to functional atelectasis. Subcrepitant râles which are elicited only after cough are due to edema or infiltration of the alveolar walls; these areas fail to "light up" under the roentgenoscope on inspiration. Moist râles heard on ordinary inspiration over a limited area of the pulmonic field and associated with modified breathing are strongly suggestive of small cavitation.

A peculiar friction rub heard over the sternum anteriorly or over the thoracic vertebrae posteriorly in cases of pneumothorax is due to the pendulum-like movement of a movable mediastinum swinging back and forth with the respiratory cycle. The marked distention and contraction of the vicariously dilated lung in cases of compensatory emphysema causes the breath sound to become puerile or exaggerated in character. The author believes that roentgenoscopy and roentgenography could be used advantageously in the study of the mechanism and physical signs of many other chest abnormalities.

BREITLÄNDER. A peculiar phenomenon in amputation stumps. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 957–958.

A fine ribbon-like rarefaction running down the axis of a stump of an amputated tibia, beginning at about the middle of the upper third of the tibia, was found on comparative roentgen study of the skeleton to represent nothing more than the channel of the nutritive artery. This was observed by the author in several cases, and confirms similar previous findings.

BRUNETTI, LUDWIG. Comment on Claus' paper on the "Shape of Fluid Levels in Diseased Nasal Sinuses as Seen in the Roentgenogram." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 726–727.

The roentgen pictures of convex fluid surfaces described by Claus (see Am. J. Roentgenol. & Rad. Therapy, May, 1926, p. 587) as representing true convexity is nothing more than an artefact. The claim that this convexity is due to high surface tension of the medium is regarded as having no bearing on the situation. The author points out that unless the central beam is exactly tangent to the surface, the roentgenographic shadow will be elliptical instead of straight or slightly convex. Moreover, a consideration of the other physical factors such as viscosity of the fluid, adhesive power between the wall and fluid, meniscus formation, etc., all tend to negate the bizarre interpretation made by Claus. See abstract following.

CLAUS, GEORG. Reply to Brunetti's criticism of my paper on the "Shape of Fluid Surfaces in Diseased Nasal Sinuses." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 727.

See preceding abstract. Claus controverts Brunetti's criticism by showing roentgenograms of bubbles containing mercury and sodium bromide respectively in which the convex and concave surfaces are quite distinct. This, despite the fact that the central beam

was not tangential to the surface of the sodium bromide solution.

Buchman, Joseph. The relationship between vertebral epiphysitis and spinal deformity. *Arch. Surg.*, 1926, xiii, 568–577.

Vertebral epiphysitis is not found in deformities of the spine of known origin, such as poliomyelitis, Pott's disease, rickets, torticollis, congenital deviations and inequality of the lower limbs. The active or acute stage of vertebral epiphysitis is more commonly seen in the mild deformities and less commonly in the severe ones. All that remains in the severe deformities are the end results. Vertebral epiphysitis causes a derangement in the epiphyses which starts a cycle of events in accordance with Delpèche's law, and the pathogenesis of the resultant spinal deformities is the same as in rickets, poliomyelitis and Pott's disease.

A report is given of 2 cases showing negative clinical symptoms and definite roentgenological signs, the patients subsequently developing deformities. While under observation certain clinical evidences of epiphyseal derangement appeared, namely, occasional pain, tenderness, and in the second case, rapid growth.

Carpenter, E. R. Encephalography. *Am. J. M. Sc.*, March, 1927, clxxiii, 333–342.

Encephalography by air injection by the lumbar puncture and after trephining was performed on 63 patients, the details of the cases being summarized in a table. In addition to the restricted group of patients with brain tumor, hydrocephalus, or abscess where the trephine method is employed for diagnosis and localization, encephalography is indispensable in the investigation of many patients troubled with headaches, petit mal, convulsions, impaired mentality, and other vague neurological complaints of a more or less chronic or recurring nature. Encephalography by the lumbar puncture method under ether anesthesia with the patient in the upright sitting position practically is devoid of the serious reactions met with when made under local anesthesia and is not more dangerous than many other useful procedures such as tonsillectomy and appendectomy, except in patients with well-developed brain tumors, with abscess, or with communicating type of hydrocephalus. Distention of the membranes or reaction from the presence of air in this form of encephalography is beneficial in certain types of headaches and possibly in other conditions.

Of 40 lumbar puncture air tests, 19 showed normal findings, 21 abnormal, and 7 were indefinite. One lumbar puncture patient, aged two years, with hydrocephalus died ten days after the test. Of 23 primary trephine air tests, 4 showed normal findings and 19 abnormal. One trephine patient in coma died two hours later, 2 with cerebellar tumors and choked discs died one week after operation. Possibly death was hastened by retained air as drainage of the ventricles could not be re-established and the air was not removed or replaced by fluid. Seventeen cases are cited briefly and some of them are illustrated by roentgenograms.

d'Amato, G. The value of a combination of cholecystography with a simultaneous examination of the gastrointestinal tract. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 705–712.

The practical advantages of the combined examination may be summarized as follows: (1) The examination combines the advantages and results of the simple cholecystography and the gastric examination. If the method is carried out satisfactorily it enables the detection of stones, distention, shrinkage and other pathological conditions of the gall-bladder, as well as the pathological changes in the stomach or duodenum. (2) It furnishes proof of adhesions between the gall-bladder and the stomach, duodenum or colon. (3) It very frequently furnishes the explanation for distortions of the stomach and duodenal shadows. (4) It may give additional information as to the reasons for rarefactions in the gall-bladder shadow. (5) It furnishes additional grounds for the choice of a rational treatment; and (6) it appears to be entirely harmless and without great inconvenience to the patient.

The author recommends that the procedure be carried out systematically especially in those numerous cases in which cholecystitis, duodenal ulcer and appendicitis may be confused.

Dillon, Jakob. A contribution on diseases of the diaphragm. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May 6, 1926, xxxiv, 636–654.

The discussion is confined to the following two conditions: relaxation of the diaphragm and diaphragmatic hernia. The symptoms in these diseases may be classed under three headings: (1) those of the heart; (2) those of the lung and pleura, and (3) those of the gastrointestinal canal. A consideration of the symptomatology and the various diagnostic methods leads to the conclusion that only the roentgen examination permits a correct diagnosis of diseases of the diaphragm in general and enables a differentiation between relaxation and hernia of the diaphragm.

Relaxation of the diaphragm is accompanied by a sufficiently characteristic symptom-com-

plex to put it in the category of a separate disease entity. The condition is not nearly so uncommon as is usually assumed. Regarding the pathogenesis of relaxation of the diaphragm right-sided relaxation can occur only in the rare case when the gas-distended transverse colon is forced between the liver and the relaxed diaphragm and exerts a constant pressure on the latter similar to that produced by the gastric bubble in the left sided condition. The most reliable diagnostic symptoms for differentiating between relaxation and hernia of the diaphragm are the Müller experiment, the Arnsperger symptoms, the symptom of peristalsis of the empty stomach and the expiratory acceleration of diaphragmatic movement.

Reports are given of 7 cases of relaxation of the diaphragm observed by the author; 3 of these had accompanying heart symptoms, 1 had lung and pleural symptoms, and 3 gastrointestinal symptoms. In addition an interesting case of diaphragmatic hernia is described in which the stomach and the large and small intestines filled almost the entire left side of the thorax.

As indicated, the author explains the almost uniform occurrence of relaxed diaphragm on the left side as due to the fact that in the process of consuming food sufficient air is swallowed to distend the stomach and thus lift the relaxed diaphragm. Undoubtedly a congenital insufficiency in the structure of the diaphragm is present but this alone is not sufficient to produce the condition.

ESAU. Spur formation on the olecranon. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 679–683.

The olecranon spur, a peculiar structure on the ulna, appears to occur mostly in males and is apparently not associated to any special degree with excessive muscular strain in the individual. The author does not believe that the condition is formed by continued or temporary muscle strain (especially of the M. triceps brachii upon its point of insertion) since in cases where it occurs unilaterally it is usually found on the side which has been least subjected to strain. These spurs are demonstrable in about 2 per cent of males and much less frequently in females.

Another striking feature is that these spurs are apparently not found during the developmental years but only after the age of thirty. The author in an examination of several thousand individuals during the past seven years has never observed these spurs in persons under thirty years of age. In contrast to occipital spurs those on the olecranon do not seem to be hereditary. So far as the author can judge, these spurs are apparently skeletal variants and are not associated with inflammation or other pathologic processes. Fracture of the olecranon spur occurs only very rarely and the transverse line of rarefaction often seen in these spurs is usually not the result of fracture but due to resorption of lime. A case of true fracture is described.

FISCHER, A. W. The roentgen and differential diagnosis of intestinal polyps. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 716–720.

Although polyposis of the colon and rectum may be determined rectoscopically, this procedure can give no information regarding the extent of the process. This very important information for the surgeon can be determined readily by the roentgen examination. The passage of a contrast meal is unsuitable for this purpose, and with too great a filling of the colon by contrast enema the polyps become obscured and show only a hardly noticeable haziness of outline. When the intestine is only slightly filled and is thereupon distended with air the intestinal wall appears finely mottled in the roentgenogram owing to the fine residue of opaque material adherent everywhere between the polypi. The employment of this combined enema-air injection permits an exact determination of the extent of the process and enables the surgeon to decide upon a definite procedure. The procedure is illustrated by the report of a case occurring in a woman aged twenty-two.

HUNTER, DONALD. A case of osteogenesis imperfecta. *Lancet*, Jan. 1, 1927, i, 9–12.

A report is given of a case occurring in a boy aged seventeen who had suffered numerous fractures from childhood on. He was unable to walk and could stand only with difficulty. A complete clinical description is given. The roentgenogram of the skull showed the vault too large in proportion to the bones of the face. The distance between the tables was reduced so that the bones appeared thinner than is normal. This was especially noticeable from the bregma to the region of the lambda at which point there was an angular projection. From there the occiput sagged downward considerably. There was also loss of prominence in the frontal region of the skull. The structures forming the base of the skull appeared to be flattened in their vertical dimension. This probably accounts for the lack of prominence of the mastoid shadows, and for the slight shallowness of the sella turcica which in other respects appeared normal.

All the long bones showed shortening and bowing. The shadows of the bones were hardly

more dense than those of the surrounding soft tissues. There was very great thinning of the cortex, more noticeable on the convex side. The spongiosa both of diaphyses and epiphyses was extremely faint so that in places the normal pattern could not be discerned. The epiphyseal lines appeared normal. There was very little evidence to indicate the sites of the old fractures. In the region of the lesser trochanter of the right femur there were two fine transverse lines of comparative sclerosis running parallel. There was nowhere evidence of the formation of callus nor of periosteal new bone. There was no suggestion of cyst formation. This case of osteogenesis imperfecta was associated with blue sclerotics but the family history was entirely negative. Corresponding to the early onset of three weeks there is dwarfism and deformity of the skull. The long bones have been fractured at least thirty times without violence, the left tibia alone escaping. Chemical studies of calcium and inorganic phosphate in the blood serum showed normal conditions. The total excretion of calcium on a known low calcium diet was found to be the same as in a normal control.

KEY, J. ALBERT. Brittle bones and blue sclera; hereditary hypoplasia of the mesenchyme. *Arch. Surg.*, 1926, xiii, 523–567.

Idiopathic bone fragility may be classified as follows: (1) hereditary form; hereditary hypoplasia of the mesenchyme; (2) nonhereditary forms; (*a*) osteogenesis imperfecta; (*b*) osteopsathyrosis with white sclera; (*c*) osteopsathyrosis with blue sclera; (3) probably not hereditary: osteosclerosis fragilis generalisata, or marble bones. The term hereditary hypoplasia of the mesenchyme is used to describe the condition usually called brittle bones and blue sclera, because many of the mesenchymal tissues may be found to be underdeveloped. This type of fragilitas ossium is hereditary, and in addition to the brittleness of the bones and blue sclera, is characterized by small stature, hypermobility of the joints and a weakness of the fibrous structures throughout the body. The cases that reach adult life tend to develop progressive deafness. The blue appearance of the sclera is not due to a deposit of pigment, but to an abnormal translucency and quality.

The fractures in these cases are not spontaneous but due to definite causes except that the violence causing a fracture is less than that necessary to break normal bone. The deformities are due to malunion of old fractures and not to bone softening. The roentgenographic appearance of the bones is described in detail. In the case cited by the author the roentgenograms showed a general decrease in the size of the bones, a thinning of the skull and a concentric atrophy of the long bones. There was cortical striation of compact bone and coarseness of structure of spongy bone. The bones not subjected to disuse showed little rarefaction. There are cases in the literature in which the bones are reported as being rarefied and exhibiting eccentric atrophy. Whether or not the two types occur in the same family is not known. There have been no adequate roentgenographic reports upon several members of one family. Such studies are needed to clear up this phase of the subject.

Examination of the bone removed at operation showed it to be unusually hard and brittle. The structure was similar to that of normal bone except that the lamellae were irregularly arranged and the amount of compact bone was decreased by the presence of numerous large canals. The cortex of the tibia was honeycombed with large canals containing a very vascular connective tissue. The presence of these canals explains the cortical striations seen in the roentgenograms. They also explain the ease with which the bones are fractured. It is probable that there is some abnormality in the quality of the fibrous matrix of the bone. It is probable, also that it involves all the collagenous tissue in these patients, which explains the friability of the blood vessels, fascia, periosteum, and subcutaneous tissues noted in the author's case.

The fractures tend to heal rapidly. The blood pH in this case tended to the alkaline side of the normal range and the calcium and phosphorus tended to be a little high. The author's studies of hypoplasia of the mesenchyme seem to indicate that it is an anomaly of development rather than a derangement of metabolism. No evidence of any endocrine disturbance was observed.

KLOIBER, HANS. Axillary gland in the roentgen picture. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 670–679.

The axillary glands are seen as shadows in the lateral wall of the thorax varying in size from a pinhead to a hazelnut, of uniform density and usually showing sharp outlines. The glands may occur in regular groups or distributed along an almost straight line. Reports are given of 2 cases of pulmonary tuberculosis in which the axillary glands were found incidentally during a roentgenographic examination. In another patient suffering from deposits of calcium in the subdeltoid bursa the roentgenogram also disclosed an axillary gland on the same side. In all these cases the glands stood out as abnormal shadows

of varying size and shape but showing the characteristics mentioned above.

KNOTHE, WERNER. On the roentgen examination of the operated stomach. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 688–690.

A young man aged twenty-three had had several operations, the last one a gastroenterostomy for the treatment of ulcer, and complained of indefinite gastric symptoms. A careful roentgen examination over the region of the anastomosis showed no indications whatever of a pathological condition. After three hours, a slight amount of barium still remained in the stomach and roentgenoscopy at this time revealed a spot about the size of a pea. Serial roentgenograms were taken under compression and these showed adjacent to the spot which was interpreted as an ulcer, a uniform, linear shadow running from this spot practically vertically downward, a shadow which was not visible in the roentgenoscopic examination. This filament was interpreted as a piece of silk thread hanging down into the small intestine. Operation confirmed the diagnosis. There was an ulcer in the posterior circumference of the anastomosis, and from the caudal region of the ulcer a silk thread about 20 cm. long and knotted at the distal end was found extending into the jejunum. The thread was removed, and the patient recovered from the operation relieved from symptoms.

LANGLEY, ROBERT W. Fluoroscopic study of the heart. *Radiology*, January, 1927, viii, 27–33.

A discussion is presented of the elements of the interpretation of the roentgenoscopic pictures of the heart shadow. Distinct types of partial or total enlargements of the heart characterize different types of valvular disease, congenital lesions, gross enlargements from hypertension, myocarditis, etc.

Orthodiagraphy may play a most important rôle in the diagnosis of congenital heart lesions. Where typical clinical signs are found the diagnosis is quite simple. Pericardial adhesions and effusions give characteristic orthodiagraphic shadows.

LOTSY, G. O. Slowly developing temporary paraplegia in a tabetic going around with a fresh fracture of the spine and neck of the femur. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, May, 1926, xxxiv, 655–656.

The patient, an old man, aged sixty, with an undiagnosed case of tabes slipped and fell but was able to get up and walk about for about three weeks thereafter. A paresis of both legs then developed which progressed to total paraplegia. Incontinence of urine appeared also. There then developed a large tumor over the lumbar region of the spine and of the thigh. The roentgenographic diagnosis was fracture of the neck of the femur and fracture of two lumbar vertebrae with formation of enormous masses of callus. There were clinical symptoms of tabes present. After specific treatment a gradual improvement in the paraplegia developed, bladder function became normal and the tumors over the spine and the thigh diminished to less than half. The interesting feature about this case is the ability of the broken leg to function fairly normally which was made possible by the existence of the deep analgesia. The enormous regression of the syphilitic callus masses is also worthy of note.

LOTSY, G. O. Extensive osteitis fibrosa cystica (Recklinghausen) of the hip joint. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 657–658.

The case occurred in a young woman aged nineteen who two and a half years previously, shortly before her first pregnancy noticed mild pains in the right hip which caused her to limp slightly. These symptoms increased gradually so as to necessitate the use of a cane. Physical examination showed a slight shortening of the right leg. The roentgenographic examination revealed all the typical symptoms of osteitis fibrosa cystica, namely, resorption, curvature, swelling, bone septa, and honeycombed structure. There was a circular bone septum which apparently represented the wall of a cyst. Osteomalacia was excluded from the fact that the swollen mass of bone was not painful to pressure; because only one side of the pelvis was involved and the typical heart picture was absent, and finally because the disease began before pregnancy and the latter had exerted no noteworthy effect on the course of the disease.

LOTSY, G. O. A symptom-complex of the angle of the pons cerebelli caused by disease of the petrous bone. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 658–660.

The patient, a man aged sixty, was suffering from a total peripheral, right sided facial paralysis, protracted deafness of the right ear, attacks of trigeminal neuralgia and other symptoms. An occipitofrontal roentgenogram was taken with the head slightly inclined, the frontal tuber resting upon the plate. The roentgenogram showed quite a difference between the shadows of the right and left petrosal bones. In the case of the right petrous bone there could be seen only a few islands remaining which possessed normal shadow depth; and the dis-

tance from the upper to the lower islands was greater than that from the upper islands to the lower margin of the left petrous bone. The impression obtained from the examination was as if the diseased petrous bone had been distended by a tumor and partly resorbed. This finding was checked by further roentgenograms taken in the axial direction and by the Stenvers technique. In this case there were no evidences of compression of the cerebellum, of the pons or the medulla, nor were there the general signs of cerebral tumor. Consequently it is assumed that the destruction of the petrous bone was probably due to primary disease of that bone rather than to a secondary condition caused by pressure or proliferation of the tumor in the region of the angle of the pons cerebelli.

LÜDIN, MAX. The solitary, circumscribed rounded shadow in the lung roentgenogram. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 899–904.

Reports are given of 8 cases comprising the following: primary lung sarcoma, primary lung carcinoma, intrathoracic struma, lung echinococcus, interlobar empyema, pulmonary abscess, pulmonary actinomycosis and pulmonary infarct. In each of these cases the roentgen picture was characterized by the presence of a single circumscribed rounded shadow. The fact that such a striking roentgen symptom occurs in the most diverse lung conditions makes the differential diagnosis very difficult and often impossible. Emphasis is laid on the fact that the roentgen examination does not play the main rôle in the diagnosis of pulmonary conditions, and stress is laid on the importance of an exact knowledge of the clinical findings.

MCPHEDRAN, F. M., and WEYL, CHARLES N. Clinical and physiologic deductions from synchronized roentgen-ray exposures. *Am. J. M. Sc.*, March, 1927, clxxiii, 313–322.

There is evidence that cardiac movement and vascular pulsation cause more extensive and complex pulmonary movements than has been hitherto recognized. The effects of vascular displacement and vibration in the blurring of roentgenographic detail are important. Artefacts are produced to which have been given a pathologic interpretation. By synchronization of exposures with late diastole, such artefacts may be eliminated and finer detail, normal and pathologic, recorded with marked enhancement of stereoscopic accuracy. The method is of value in the early recognition and differential diagnosis of discrete tuberculous infiltrations, especially those which are infantile in type, beginning bronchiectasis, bronchopneumonia and other processes manifesting themselves by changes in the relative density of the pulmonary structures associated with slight and equivocal or no physical signs.

MATHÉ, CHARLES P. Retroperitoneal lymphoblastoma simulating kidney neoplasm. *J. Urol.*, March, 1927, xvii, 357–366.

A report is given of a case occurring in a woman aged twenty-nine who was admitted with a diagnosis of pyonephrosis. The pressure from the tumor arising in the lymph tissues contained in the retroperitoneal space led to confusion in the diagnosis. A perirenal tumor by its pressure on the ureter and pelvis may give one the pyelographic picture of kidney tumor. This pressure when also exerted on the renal vessels may lead to primary kidney atrophy rather than hydronephrosis, provided, however, that there is a compensatory hypertrophy of the opposite normal kidney. The tumor was discovered to be inoperable and the mass received 2500 mg-hr. of radium. Fever, rapid pulse and respirations persisted and deep roentgen therapy was employed for palliation, $\frac{1}{4}$ of the erythema dose being given in divided doses. The patient died, and necropsy findings verified the observation that deep roentgen therapy may cause marked regression of neoplasms without necrosis. A considerable regression of the tumor as a result of radiation therapy was noted. It was reduced from a huge mass to a small fibrous scar 2.5 cm. in diameter encircling the left kidney, and in spite of this rapid and marked regression there were no areas of necrosis.

OLCH, ISAAC Y. Chronic cholecystitis. *Am. J. M. Sc.*, March, 1927, clxxiii, 368–374.

One hundred consecutive cases of chronic cholecystitis are reviewed, in which the cholecystogram was used in the diagnosis and in which cholecystectomy was performed at the Barnes Hospital, St. Louis, Mo. Surgical specimens routinely submitted to the surgical laboratory were examined by the author. Since the introduction of cholecystography there has been noted a gradual change in the gall-bladder material removed at operation, and with it has come a clearer understanding by the surgeon of what constitutes cholecystic disease.

Extensively scarred and thickened gall-bladders with or without stones represent the end stage of a long standing disease. These can usually (70 per cent) be diagnosed by careful history and physical examination. Cholecystography in these cases has been an infallible corroborative laboratory procedure. Cholecystography is an index of physiologic

function of the gall-bladder, and with this in mind, cholecystitis can be detected long before marked gross changes have occurred in the gall-bladder. In every case so diagnosed cholecystectomy has resulted in complete relief of symptoms. Chronic hepatitis is constantly associated with chronic cholecystitis no matter how slight the latter may be.

Sanford, Conley H. Syphilis of the stomach. *Radiology*, January, 1927, viii, 73–75.

A report is given of a case occurring in a housewife aged twenty-three, who had been complaining of pain in the epigastrium of eight months' duration with "indigestion" for one year. The Wassermann reaction was four plus and the roentgen examination revealed the following: Habitus, hyposthenic; and stomach unusually high considering habitus. At the junction of the pars media with the pars pylorica there was an area of constriction in the wall of the stomach at which point the lumen was only 3 cm. in diameter, producing a partial hour-glass effect. The above abnormality persisted through the entire time the stomach was observed (about two hours). The pylorus was markedly spastic. The stomach was practically free from visible peristaltic waves, and was empty at six hours. No abnormalities were detected elsewhere in the gastrointestinal tract. The patient received a peptic ulcer diet, was advised to remain at rest in bed and received arsphenamine. She quickly gained in weight and the symptoms subsided. A roentgenogram taken about a year later showed the stomach to be normal.

Sante, L. R. Massive collapse of the lung. *Radiology*, January, 1927, viii, 1–13.

Massive atelectatic collapse of the lungs is a definite clinical entity and the name should be reserved for cases following the typical clinical course where there is collapse of the previously well aerated lung. Congenital atelectasis does not belong in this category. Massive collapse is characterized by sudden collapse of one or more lobes in a lung previously well aerated, from some unknown cause. It is most frequently observed after abdominal operations, wounds and other injuries such as fractures of the pelvis or femur; but it may follow apparently trivial injuries.

Roentgenographically there is a dense consolidation corresponding to one or more lobes or to the entire lung, rather homogeneous in character and resembling consolidation from pneumonia. The narrowing of the chest on the involved side, approximation of interspaces, elevation of the diaphragm and the drawing over of the heart and mediastinal structures makes the condition readily diagnosable. The cause is not known but it seems most probable that some infection or insult to the region of vagus supply produces a reflex action on the bronchioles, permitting their temporary collapse. Once approximated, the walls of these bronchioles are held in apposition by cohesion, collapse of the lung rapidly following, owing to absorption of the alveolar air by the circulating blood. Relief of the obstruction results in sudden re-inflation of the lung. Three cases are reported.

Singer, J. J. Bronchography. *Arch. Surg.*, January (Part II), 1927, xiv, 167–174.

The injection of iodized oil, 40 per cent, is of great benefit in combination with careful physical examination, to those who have had considerable experience with suppurative lung conditions. It should not be used in any case in which the simpler methods can be employed. It shows excellently the bronchial tree with abnormalities present, and when properly used is harmless. The method recommended for children is the introduction of the oil through a trocar needle, resembling a tracheotomy tube, into the trachea under sterile precaution. The method recommended for adults before attempting more complicated procedures is the injection into the pharynx of 20 c.c. of oil while the patient pulls out his tongue as far as possible. The alternative method suggested for adults is the administration of the oil through a tracheal catheter introduced under indirect illumination of the pharynx. When bronchoscopy is employed for other purposes the oil may be administered under direct laryngoscopic examination with the patient lying on the back and the head extended over the table; or else through the bronchoscope introduced directly into the lung. The five methods of administration are described in detail.

The value of bronchography lies in the definite mapping out of lung structure either normal or altered by pathologic conditions. It requires considerable experience to be able to interpret these shadows, especially with such an opaque substance. In view of the fact that the lung fields may extend anteriorly and posteriorly from 6 to 12 inches, one can readily understand how superimposing shadows will complicate the roengenogram. Many dense shadows in the roentgenogram may be tumor masses, collapsed lung tissue or cavities filled with secretion. The opacity of the iodized oil, 40 per cent, when introduced into the lungs of these patients will often give startling pictures of pathologic conditions that were not suspected.

Todtenhaupt, W. Two cases of dislocation of the semilunar bone. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 700–701.

These cases are reported because of the relative rarity of such dislocations.

The first occurred in a man aged fifty-four who sustained the injury in a fall. The roentgenogram of the hand lying flat showed that the os lunatum was displaced somewhat distally from its normal position. A somewhat greater density of shadow of this bone in the roentgenogram suggested that the displacement was also slightly volar. A lateral roentgenogram disclosed the volar luxated lunatum still more distinctly, and in addition a certain degree of twisting. Surgical removal of this bone was followed by a return of approximately normal function to the wrist.

The second case occurred in a man aged twenty-nine who sustained the injury by excessive strain on the right hand. The roentgenogram showed the os lunatum totally luxated volarly and proximally. Its position in the proximal row of carpal bones appeared to be entirely free except for several fine bone fragments. The lateral roentgenogram disclosed the dislocated lunatum projected over the end of the ulna.

Tucker, Gabriel. Technic of bronchoscopic introduction of bismuth subcarbonate and iodized oil, 40 per cent, for pneumography. *Arch. Surg.*, January (Part II), 1927, xiv, 175–183.

The bronchoscopic introduction of opaque substances into the lung for pneumonography is safer for the patient and more accurate in its localization than introduction by blind methods. Bismuth subcarbonate insufflation as originated by Jackson has given the best results in outlining the trachea and larger bronchi and in bronchiectatic dilatation of the larger bronchi. Iodized oil, 40 per cent, is best in abscess cavities and in the periphery of the lung. The most accurate pneumonogram is obtained by the bronchoscopic introduction of the opaque substance on the roentgenoscopic table. The entrance of the opaque substance is observed roentgenoscopically; and the plates are to be made without transfer of the patient to another table. These considerations justify the choice of the bronchoscopic method of introduction of radiopaque substances for pneumonography in addition to the great diagnostic value of the study of local conditions afforded by direct vision through the bronchoscope preliminary to pneumonography. A description is given of the technique and of 2 illustrative cases.

von Müller, Friedrich. Errors and difficulties in the diagnosis of pulmonary tuberculosis. *Am. Rev. Tuberc.*, February, 1927, xv, 188–193.

Today a good roentgenogram is indispensable in every case because every tuberculous infection produces an infiltration and a swelling of the local lymph nodes. Therefore a tuberculous focus should not escape the eye. Mistakes are possible only when the focus is behind the ribs or within the shadow of the vertebral column or the heart. A tuberculous focus of the lungs hardly ever heals without leaving a scar, and we are therefore able to judge even after many years whether a tuberculous infection has been present or not. It is not exceptional to see cases in which a cure of tuberculosis had been called a most splendid result, while the roentgenogram shows in fact there never had been a tuberculous infection at all. Percussion and auscultation are indispensable in explaining the roentgenogram; at least the roentgenogram has shown that an over-refined physical examination very often has led to error.

It is obvious that an examination by physical methods tells us only about physical conditions. The acoustic methods of percussion and auscultation and the optic examination by roentgen rays permit us only to distinguish normal air-containing lung from infiltrated and consolidated lung or perhaps an effusion of fluid or air in the thoracic cavity. But neither percussion nor auscultation nor the roentgen ray permits us to distinguish the histological character of an infiltrative process, and the author denies that we are able to distinguish sharply between exudative and proliferative processes.

Wallace, W. H. Report of a case of a tri-ped baby. *Radiology*, January, 1927, viii, 71–72.

Pictures are presented of a case observed in a female child six and a half months old. It was well formed except for a mass over the left buttock from which projected a well-formed foot and ankle. The roentgenograms show that the tibia and femur were well formed and the fibula absent. The head of the femur rested against the right ilium, going clear across the buttock. The colon, injected with a barium enema, was found not connected with the mass over the buttock, and it would therefore not interfere with a surgical procedure.

At operation, the leg was found to be in a sac and some intestine (extraneous to the child's intestinal tract) was also found showing that the genesis of the condition was a teratoma. The child died.

White, Edward W. Hydronephrotic double kidney with megalo-ureter. *J. Urol.*, April, 1927, xvii, 439–447.

A report is given of a case in a housewife aged thirty. There was a duplicate kidney pelvis and bifid ureter complicated by advanced hydronephrosis and megalo-ureter containing calculi. Ordinarily the taking of pyelograms should suffice to demonstrate bifid ureter, but if one of the branches of the bifid ureter be occluded or if the common part of the ureter be occluded, as occurred in this case, then the pyelo-ureterogram will fail. The introduction of 12 c.c. of sodium iodide solution caused considerable pain in the right lumbar region. A ureteropyelogram revealed the catheter in the left ureter to have taken an abrupt turn to the right and advancing toward the right renal pelvis instead of to the left, although the catheter had been passed into the left ureteral orifice. All roentgenograms showed distinctly massive shadows in the left pelvic ureter at the bladder junction. A successful nephrotomy was done.

Wülfing, Max. Accessory bones of the elbow. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 684–688.

True accessory bones in the elbow have as yet not been established with certainty. The observations reported in the literature are believed by the author to have been incorrectly interpreted because most of those cases were caused by trauma, often extremely slight. A case is reported in a young man aged twenty-one in whom the roentgenogram of the right elbow showed a free bone shadow below the median epicondyle, four, small, free, oval shadows below the lateral condyle and between the capitulum humeri and radii. There was also visible a fracture line in the median epicondyle. Although the appearances suggested a true congenital anomaly, further study of the case made it clear that the picture was the result of trauma.

ROENTGEN AND RADIUM THERAPY

Borak, J. Post-operative irradiation of breast cancer. *Radiology*, December, 1926, vii, 471–474.

It must be borne in mind that the solution of the problem of postoperative irradiations consists in adapting the technique of the irradiations to the conditions existing before, during and after the operation. This is true not only of breast cancer but also of all other tumors.

The author has pursued the following modified technique at the Holzknecht Institute. The radiation is applied in one field to the scar area, axilla, and supraclavicular fossa, target distance 40 cm., in addition a smaller field is added to include the posterior aspects of the axilla, target distance 30 cm.; 6 H or one-half skin erythema dose through 4 mm. Al, 150 kv. The irradiation is given eight times within twelve months; at first twice at intervals of two weeks, and then twice at intervals of four weeks, and twice at intervals of six weeks, and the last two times at intervals of eight and ten weeks respectively. Of 26 patients receiving such treatment in 1919, 9, or 34 per cent, were still living free from recurrences in 1926. Of 37 patients thus treated in 1920, 17, or 46 per cent, were well after a lapse of five years since operation. Six patients, or 10 per cent, of the total had died without any recognizable recurrence of cancer. No account is taken of patients lost sight of. Owing to the fact that the attendance of patients for postoperative irradiation was not very carefully controlled, many came for the first few treatments but did not come again. This is possibly the reason why the above results are not quite so good as those recorded in the Kiel Clinic where 57 per cent of the patients were free from recurrences for five years.

A priori it seems improbable that the percentage of cures following operation in the first Steinthal stage would be increased appreciably by postoperative irradiation. On the basis of reported statistics it is quite evident, however, that postoperative irradiation must be regarded as indicated in cases included in the second Steinthal stage. Cases in the third stage can scarcely be regarded as particularly suitable for a radical operation and roentgen treatment in such cases is merely palliative.

Colwell, Hector A. A case of lymphosarcoma of the naso-pharynx treated with radium and *x*-rays. *Lancet*, Feb. 26, 1927, i, 437.

A report is given of a case in which an extensive lymphosarcoma disappeared under radiation therapy without any operative procedure other than that necessary for the application of radium, and in which no recurrence was seen during a period of over six and a half years. When first seen the patient was a somewhat cachectic man aged thirty-four, who complained of obstruction in the nose and gradually increasing deafness. On both sides the glands in the posterior triangle of the neck were enlarged and indurated. A portion of the growth was removed for histological examination and the clinical diagnosis of neoplasm was con-

firmed by the report that the specimen showed lymphosarcoma.

The condition was quite inoperable and palliative radiation therapy was decided upon. Two 50 mg. tubes of radium bromide were inserted, one into the main nasopharyngeal neoplasm and the other into the mass on the left side, both tubes being left in place for six hours. Five days later roentgen treatment was commenced, one Sabouraud dose being administered through 3 mm. Al to both sides of the neck, the rays being directed upward and inward toward the nasopharyngeal region. In about a week from the beginning of treatment the condition was much improved and five days later the roentgen treatment was repeated and after another interval of five days radium was again inserted for six hours as before into the much shrunken growths. About four weeks after beginning of treatment the post-nasal space was found to be free of growth so far as macroscopic evidence was concerned. During the following five months ten further applications of roentgen rays were given. The patient has been kept under observation until the present time and appears well and healthy with only a few telangiectases on the neck due to the roentgen treatment.

Haxthausen, H. Finsen treatment of lupus vulgaris with intensified light and application of a special filter for a partial absorption of luminous heat rays. *Strahlentherapie*, 1926, xxii, 337–351.

The author employs a filter consisting of cobalt chloride dissolved in absolute alcohol. This filter has the property of absorbing all the rays from green to red, with the exception of a small zone in the red, but is transparent to blue, violet and ultraviolet down to about 250$\mu\mu$. By employing such a filter and increasing the strength of the light source it is possible to keep the heat effect down to the old value while at the same time increasing three-fold the presumably most effective therapeutic rays in Finsen treatment. The results of this treatment were observed in 64 old, previously refractory cases. The treatment followed the usual principles of Finsen therapy augmented by universal carbon arc light baths. Cure of lupus vulgaris was obtained in 14 of these cases, improvement in 31, and no improvement in 19.

In many of the cases where cure was not obtained, it is believed that failure was due to antecedent roentgen treatment which is apparently antagonistic to light treatment in the sense that it makes the latter more painful and delays healing. In a total of 18 early cases, cure was obtained in every one by means of the new therapy, and the time required appeared to be considerably shorter than that required in similar cases by the usual Finsen therapy plus light baths.

Isaacs, Raphael. Effect of roentgen ray irradiation on red blood cell production in cancer and leukemia. *Am. J. M. Sc.*, 1926, clxxi, 20–37.

Irradiation stimulates in susceptible cases changes which are normal in the life of a red blood corpuscle, only the rate and time of initiation being changed. Effective short wave roentgen irradiation over any part of the human body may be followed in from one to twenty-four hours by one of three responses of the young red blood cells. The granule red cells (corpuscles showing only a refractive granule) may show an appreciable and sustained increase in percentage, or a very transient, or negligible increase. Where there is an absolute or relative increase in the percentage of granule red cells there is frequently a decrease in the absolute and relative percentages of reticulocytes, unless the marrow is hyperplastic.

Cases of cancer and leucemia in which the increase in granule red corpuscles after irradiation is significant and sustained (two or more days) show a definite clinical improvement, and no leucopenia develops. In those cases in which there is no evident increase in the granule red corpuscles after irradiation, there is usually no clinical improvement in the irradiated lesion. If the increase is temporary (twenty-four hours or less) and is followed by an abrupt decrease the results are those of too much irradiation, a leucopenia develops and the patient may become worse clinically.

In terms of the degree of red cell maturity, clinically effective roentgen irradiation causes an increase in the degree of maturity of the red cells liberated into the peripheral circulation, starting during the period of exposure and lasting one to four days. This may be followed by an increase in some cases in the more immature red cells (reticulocytes). The most frequent effect on the count of red cells in the peripheral circulation is a gradual temporary decrease with an increase in the color index which often becomes more than unity. The change in the percentage of immature erythrocytes is one of orderly stimulation to maturation, through an effect on these cells in the bone marrow and possibly in the blood stream. It takes place quickly without an appreciable variation in the red cell count and is different from the changes following the redistribution of the cells in the peripheral vessels. The percentage changes of the immature blood cells

follow therapeutic irradiation over any region of the body and appear to be a systemic effect of localized exposure. The changes in the relative percentage of young red cells after therapeutic irradiation are similar to those taking place after blood transfusion.

The period between the application of the rays and the beginning of definite maturation changes in the red cells is probably a matter of minutes as compared with hours or days for the leucocytes and weeks for carcinoma tissue. Other points of similarity between the erythrocyte changes after effective irradiation and those of cancer tissue are: (*a*) development toward maturity and senility; (*b*) occasional period of immaturity subsequently; (*c*) so-called stimulation by weak doses and depression by large doses with occasional absence of effect after irradiation of intermediate intensity. From the evidence of the effect of irradiation on young red blood cells, all roentgen irradiation may be considered as stimulative. Small doses may stimulate to division, large doses may stimulate to maturity and to death from senility, the rate for each tissue varying with its specific growth properties.

JENKINSON, EDWARD L. The roentgen treatment of leukemias. *Radiology*, November, 1926, vii, 379–384.

The differential diagnosis of leucemia is often difficult and can be made only through careful study of the clinical and blood findings. The author does not believe any cases of leucemia is ever cured no matter what form of therapy is instituted.

Careful roentgen therapy is at present the most satisfactory method of treatment. That life is prolonged is problematical; the number of working days is undoubtedly increased and the amount of suffering is greatly decreased. Frequent blood counts are imperative in planning the treatment of leucemia with roentgen rays. A few cases of chronic leucemia are discussed. The details of the roentgen treatment are not given.

LYNCH, FRANK W. Five year end results in the treatment of cancer of the uterine cervix. *J. Am. M. Ass.*, Nov. 20, 1926, lxxxvii, 1701–1704.

It is the author's present belief that no method has yet cured 50 per cent of cervical cancers. The ordinary panhysterectomy has no place in the treatment of cervical cancers. Better results will be obtained by radiation therapy in all cases that are suitable for truly radical surgery.

It is believed that the literature does not indicate that radium is likely to cure any more than a scant majority of so-called operable cases. There is a chance for improving the total number of cures by operating radically in early cases in which preoperative radium and possibly postoperative deep roentgen therapy have been used, provided the surgeon can perform his operations with low mortality. The author reports on the five-year end results of a series of 107 cases of cancer of the cervix of the uterus treated between March, 1916 and March, 1921, with radium or surgery at the department of obstetrics and gynecology, University of California Medical School. In a total of 59 inoperable and borderline cases receiving radium treatment alone, 1 was lost, 51 died of cancer, 2 died of intercurrent disease, 47 died within three years and only 5 (9 per cent) are alive and well after five years.

The literature of radiology is criticized for errors quoted and requoted, and the author gives a sketchy account of his own results with radium treatment. An actual study of the literature on operable cases in which only radium was used shows the series is small and the percentage of cures very low.

There were 18 cases in the author's series which were operated on; 2 early and 12 late operable, 3 early borderline cases and one which was at first inoperable until the mass had disappeared after radium treatment. The latter case is still alive and well after five years, and of the others there are 8 alive and well after five years. There was an operative mortality of 16.6 per cent. The cure in the operative cases was 57 per cent and in all patients operated on 60 per cent. The operable cases in which radium was used are too few to permit a deduction.

POHLE, ERNST A. Roentgen ray stimulating doses of the ovaries, permanent and temporary sterilization. *Am. J. M. Sc.*, January, 1927, clxxiii, 91–101.

A study of the literature reveals that no agreement has so far been reached on the question of producing temporary sterilization by radiation, or of treating the ovaries with small doses of roentgen rays or radium to correct dysfunction. It is advisable to proceed with great caution and to leave the performance of such treatments to laboratories equipped to measure the dose exactly. Temporary sterilization by radiation, and small doses of roentgen rays or radium to the ovaries cannot be recommended at present as a recognized therapeutic measure. This subject is still in the experimental stage. Three cases are briefly cited which received roentgen irradiation for

permanent sterilization; one case treated for temporary sterilization is cited and 5 cases in which small doses were applied to the ovaries. Menstruation reappeared even after a full sterilization dose in one of the cases.

PORDES, FRITZ. "Indicatio vitalis" for roentgen therapy of perimandibular phlegmons. *Strahlentherapie*, 1926, xxii, 550–553.

Inflammations following extraction, or suppuration of the gum pocket of the lower wisdom tooth may easily lead to perimandibular phlegmons dangerous to life. The author has observed that this type of inflammation may be favorably influenced in any of its manifest stages by small doses of roentgen rays (up to one-fifth of a skin erythema dose). The observations also indicate that these particular phlegmons respond more favorably than do similar affections in other regions of the body. This last statement is based on an experience with 237 cases of inflammations in the mouth. The author has treated 19 cases of perimandibular phlegmons, as indicated above, with entire satisfaction. The treatment is given as soon as possible through a large field extending from the upper boundary of the zygomatic arch down to the middle of the neck, the dose being 2H through 5 mm. Al, approximately 15 per cent of the skin erythema dose. As a rule the fever recedes in twelve to sixteen hours and frequently the abscess breaks open spontaneously.

SEIDEMANN, HANS. On the operability or inoperability of uterus carcinomas after irradiation. *Strahlentherapie*, 1926, xxii, 554–561.

The author states that F. Heimann deserves credit for first showing in 1914 the possibility of utilizing pre-operative roentgen irradiations in the treatment of uterus carcinoma. There are presented case reports of 4 women treated by intensive pre-operative roentgen irradiation followed by total extirpation of uterus carcinomas. Although a final conclusion is yet to be reached it seems safe to state that the method, especially in inoperable cases, offers a better prognosis than anything hitherto proposed.

WARD, GRANT E. Radium in the treatment of cancer of the cervix uteri. *J. Am. M. Ass.*, Nov. 20, 1926, lxxxvii, 1697–1700.

The technique of radium treatment of carcinoma of the cervix uteri as used at the Howard A. Kelly Hospital, Baltimore, is described. Three forms of radium application are employed: (1) Direct application of screened radon to the accessible growth; (2) implantation of radon seeds into the local growth or lateral extension, and (3) heavy cross firing through the pelvis from several portals over the skin.

Direct application to the cervix is best performed without general anesthesia. When the growth is chiefly intra-cervical a small rubber cot containing two or three tubes of radon is inserted into the canal. Fungating and ulcerative growths are treated with plaques alone. The dosage varies, depending on the extent of the disease, from 2500 to 3500 mc-hr. The maximum amount is rarely given at one application because of the marked reaction produced. With massive growths, radon seeds are implanted, the total amount varying from 10 to 25 mc. well distributed. If parametric involvement complicates the local condition or is recurrent after operation or irradiation, it is treated by implantation. From 1 to 3 seeds of from 3 to 6 mc. are inserted into the parametrium as the occasion demands. These implantations are followed in a few days or in three to six weeks by cross firing of the pelvis. This cross firing treatment is also given when large pelvic masses are present, but uncommonly when the disease is limited to the cervix. A heavy lead cylinder is essential to accurate and concentrated cross firing without overlapping on the skin. With it, several portals, for example, two anterior and two dorsal are given erythema doses, the rays being directed toward the intrapelvic disease; this is especially helpful for palliation of pain and prolongation of life.

A review is given of a series of 232 cases of carcinoma of the cervix uteri treated during 1921 and 1922. The results of the radium treatment are summarized in the following table:

CASES TREATED WITH RADIUM

	No. of Cases	Clinically Cured	Per Cent Cured	Primary Growth: Improved, Per Cent	Primary Growth: Healed, Per Cent
Operable	14	8	57+	29	14
Operation after radium*	8	4	50	25(2)	..
Recurrent	41	10	24.4	40	20
Prophylactic	2	2†	100	..	..
Borderline	19	4	21+	21	53
Radium and cautery	7	3	43	14+	28+
Inoperable	141	15	10	44.4	28.3

* Died from other causes: 1 lost; 1 postoperative hemorrhage.
† One in 18 months; one in 1 year 3 months.

In the operable group treated with radium alone 8 out of 14 patients were well when last seen from eight months to five years after beginning of treatment; three-year cures, 1; four-year cures, 4; five-year cures, 1 (three-year period of cure, 45 per cent). The remaining 6 died from five months to two years and ten months after the first treatment. In all cases there was improvement or healing of the primary growth, death resulting from direct extension or metastasis. This therefore shows

a clinical cure of 57 per cent with no primary mortality. Classifying as operable not only the operable cases receiving treatment with radium alone and with radium plus operation but also those receiving prophylactic treatments after operation there is a total of 24 patients, of whom 14 were well when last seen. This gives a total clinical cure in the operable class in which both operation and radium were used of 58 per cent.

In the 141 inoperable cases 44.4 per cent showed improvement, 28.3 per cent showed healing of the primary growth and 10 per cent were clinically cured. It is realized that many of these cases have yet to pass the five-year period, but the author believes that the figures will not be appreciably changed.

Barringer, B. S. Extension of life in genito-urinary carcinoma (bladder, prostate, penis, testicle). *J. Urol.*, February, 1927, xvii, 199–204.

At the Memorial Hospital, New York, there is a considerable and increasing series of bladder carcinomas which it has been possible to remove by the intravesical application of radium. It is believed that this is one field in which radium is vastly superior to operation. There is no operative mortality.

Five to 10 per cent of prostate carcinomas may be controlled by radium properly applied. It is hard to believe that operative removal would give better results. Reduction of residual urine has not been accomplished by radium treatment. Therefore in those cases in which residual urine is a troublesome factor, there is done a modified punch operation through the urethra. In the case of carcinoma of the penis when the growth is papillary in type or if infiltrating and if Buck's fascia has been penetrated but a slight distance, operation may be entirely eliminated and the carcinoma controlled by radium, as a rule, applied on the surface. If the infiltration is extensive, the penis is amputated 2 cm. beyond the growth. No routine inguinal dissection is done. The inguinal glands are treated by a combination of deep roentgen therapy and radium pack with implantation of radium in any suspicious glands. The author reports 16 out of 36 patients disease-free at present, although it is not expected that all of these will survive the five-year period. Emphasis is laid upon the fact that there is no operative mortality in the present procedure.

In no tumor has radiation therapy produced more brilliant results than in teratoma of the testis. The testicle is thoroughly irradiated with the radium pack. The course of the spermatic vessels on the side affected is also thoroughly irradiated by radium pack or deep roentgen therapy. The only operation done is the removal of the testis under local anesthesia. In 49 cases with inoperable metastases 10 have been free of signs of disease, the longest up to six years.

Cordua, R. The morphology of carcinomas of the neck of the uterus as a basis for judging their radiation sensitiveness. *Strahlentherapie*, 1926, xxii, 689–700.

The following six morphological groups may be recognized: (1) the undifferentiated, unripe carcinoma; (2) the carcinoma with tendency to glandular differentiation; (3) distinct adeno-carcinomas; (4) semiripe carcinomas with a slight tendency to formation of squamous epithelium; (5) carcinomas with a distinct tendency to squamous epithelium differentiation; (6) keratinizing, squamous cell carcinomas. It is of course understood that there occur all forms of intermediate stages between these groups. According to Schröder, the percentage of cases distributed amongst these groups is approximately as follows: Group 1, about 24 per cent; Group 2, about 3.5 per cent; Group 3, about 4.7 per cent; Group 4, about 41.5 per cent; Group 5, about 26 per cent and Group 6, about 10 per cent.

The author has examined about 40 cases, distributed among the above groups after radium and roentgen treatment in the University Clinic, Kiel, Germany. These cases were practically all first given one or two doses of 2000 to 2500 mg-el-hr. of radium followed by roentgen treatment delivered at 2 ma., point to plate spark 40 cm. The dose of roentgen rays was 90 to 115 per cent of the skin erythema dose delivered to the carcinomatous regions. This series included inoperable cases of carcinoma of the neck of the uterus and certain cases presenting recurrences after operation. A comparison of the number of survivors with those who died leads to the conclusion that the more differentiated forms of carcinoma of the neck of the uterus present a better prognosis to radiation therapy than do the less differentiated forms. These conclusions are merely indicative and should be tested on a larger number of cases before final acceptance.

Czepa, Alois. Roentgen therapeutic observations on a peculiar case of multiple skin tumors of sarcomatous character. *Strahlentherapie*, 1926, xxii, 709–720.

The case occurred in a woman aged fifty-two, in whom a year previously there had developed above the right knee a small brown oval lesion of the skin which grew and became painful and soon ulcerated. During the course

of the year several such areas appeared over the body. The ulcers at the time of admission were covered over with large, partly blackened necrotic masses. In addition to these, there were numerous nodules scattered over the body especially on the anterior surfaces. The clinical and roentgen examination disclosed nothing abnormal in the internal organs. Mycosis fungoides was eliminated as a possibility. A biopsy was made of an ulcerated and a non-ulcerated nodule and the pathologist reported "uncharacteristic granulation tissue, mycosis (?), syphilis not probable, rather tuberculosis. No typical finding."

A further histological examination indicated that this was not granulation tissue but a tumor-like structure resembling sarcoma. The condition might be summarized as that of a diffuse sarcomatous involvement, certainly not very malignant, with excessive localization in the skin. No primary tumor or internal metastases were demonstrable. Because of the wide distribution of the nodules the roentgen treatment had to be extended over a number of sittings. The ulcerations and solid nodules were extremely roentgen-sensitive. Eight H through 3 mm. Al sufficed to cause their disappearance. The only exception occurred in the case of a large ulcer which had developed on the forehead. This area required 32 H delivered within three months to cause complete disappearance.

Dieterich, W. A case of roentgen burn in spite of standardization in R units. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 705.

The patient was a woman suffering from pruritus vulvae who received one-third dose at a distance of 23 cm. at each of three treatments given four days apart. There occurred, several days after the last treatment, a swelling of the genitalia and surroundings, very pronounced itch and appearance of white and red spots over the whole region. A large area became denuded of skin and presented an open wound which healed in about six weeks. The dose in the above case was administered through 3 mm. Al, and the author points out that although the instrument was calibrated carefully for other filters no standardization was made of the radiation through the filter actually used and no biological test was made of the dose employed. The latter was calculated from the standardization factors given. Although it was the intention to deliver a total of 600 R through the 3 mm. Al there had actually been delivered only 360 R, but the filtration produced a quality of rays which were more than enough to produce an erythema. It is emphasized that the biological standardization of a particular type of radiation still remains the most important method of avoiding burns.

Freund, Leopold. An important indication for roentgen therapy. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 713–716.

Attention is directed to a perhaps little known field of usefulness for roentgen therapy in the irradiation of open wounds after the excision of large keloids, unsightly scars from malignant neoplasms, lupus foci, and pigmented nevi. In the case of the fresh open wounds after removal of keloids, the effect of roentgen irradiation is to stimulate the growth of a cosmetically desirable smooth, thin, soft, white and delicate surface with a minimum of scarring. The dose in the treatment of the above conditions is somewhat higher than the epilation dose (about $5\frac{1}{2}$ H), distributed over several successive days (6 or 7 sittings). It appears that the employment of unfiltered rays of 6 to 7 W-hardness is more suitable than the highly filtered, harder rays. It appears probable that the indications for this form of treatment may be extended further. Results like the above justify the recommendation of this combined extirpation-irradiation therapy, which may be carried out with little difficulty.

Fricke, Robert E. Treatment of carcinoma of the breast. *Radiology*, January, 1927, viii, 39–40.

Two cases with cancer of the right breast of identical nature microscopically and with a history of the same duration of the growth were treated energetically with radium and roentgen rays. The first case had by far the more extensive local lesion, apparently hopelessly advanced and the general health was poor. The patient has responded splendidly to the treatment and is in good health. The second case with a small local growth but apparently a rapid extension to the lungs failed rapidly with little benefit from radium and roentgen rays and surgical ablation of the lesion, and died four months after inception of treatment. The obvious importance of the chest plate in every case of cancer of the breast is emphasized, as is the utility of energetic treatment of even massive and apparently hopeless malignancies.

Greenough, Robert B. End results of cancer cases and the factors determining them. *Am. J. M. Sc.*, March, 1927, clxxiii, 412–420.

The end results of the treatment of cancer are determined by the following factors: (1) *Delay*. There must be no delay on the part of the patient in seeking advice immediately upon the discovery of symptoms even suggestive of

cancer. There must be no delay on the part of the physician consulted in obtaining an immediate diagnosis. Both of these elements of delay can be done away with by education and by the provision of adequate facilities for consultation and for treatment. (2) *Extent of Disease.* With our present resources, surgery and radiation, the early local case of cancer can be cured but the late and extended case cannot be cured although palliative treatment of great value to the patient can be given.

(3) *Treatment.* The end results depend largely upon the effectiveness of the treatment employed. With the exception of a few situations such as cancer of the external skin and of the cervix uteri, surgery is the method of choice. The surgical treatment in most of its common aspects has been standardized and depends partly upon the anatomy of the region affected and partly upon the mode of extension of the particular variety of cancer. Complete or radical operation is the method which yields the greatest number of cures and should be performed even in the earliest and most favorable types of the disease. Incomplete operations do not give the patient the chance of cure to which he is entitled. Surgery may be further supplemented by preoperative and postoperative irradiation, although the final decision as to the value of these measures has not yet been established. For advanced cases, unsuited to attempts at radical cure, radiation therapy with roentgen rays and with radium, occasionally supplemented by surgery, prolongs life and mitigates the distressing symptoms of the disease to an extent unequalled by any other treatment now available.

Cancer is not a single disease but many diseases, differing not only in location but in rapidity of growth and of dissemination. There are a certain number of cases so malignant and so rapid in their development that our present methods are insufficient to cope with them. A majority of cases of accessible cancer, however, are curable by methods of treatment now available in most of our modern hospitals, if only these methods can be applied in the early and favorable stages of the disease.

GROSGLIK, ADAM. The roentgen treatment of Werlhof's disease. *Strahlentherapie*, 1926, xxii, 721–725.

A report is given of a case occurring in a girl who received roentgen treatment one and a half years after a splenectomy. The roentgen treatment was applied over both legs and one thigh, the rest of the body being carefully screened so as to avoid any possible direct action upon the liver or other abdominal organs. The clinical aspects of the case are presented in detail. The hematological studies showed that a normal thrombocytosis alone does not hinder the occurrence of petechiae and subcutaneous hemorrhages. At one stage there was a high grade thrombopenia without hemorrhage. A clinical purpura hemorrhagica, at least in mild form, may occur in conjunction with a fairly normal hematological condition. There was found an unmistakable and extensive parallelism between the results of splenectomy and those following roentgen treatment. After both treatments there appeared an increased thrombocytosis, reduced period of hemorrhage, and there was a considerably reduced clotting time after irradiation. Even the thrombocyte crisis occurred after irradiation just as it did after splenectomy. It is admitted that the favorable results of the splenectomy lasted longer, but it is pointed out that the roentgen treatment was relatively mild and brief.

The roentgen treatment in this case consisted of exposure of 7 fields, each 12 × 12 cm. The dose was 2.5 H (approximately one-sixth of the skin erythema dose) upon the surface or a total of $1\frac{1}{6}$ skin erythema doses over a total surface of about 1000 sq. cm. It is calculated that each field received about $\frac{1}{48}$ of the skin erythema dose below the surface, or a total for the 7 fields of $\frac{1}{7}$ of the skin erythema dose. Attention is directed to the disparity between the small internal dose and the large superficial dose over the extremities.

HOLFELDER, HANS. Is postoperative irradiation in mammary carcinoma justified? *Strahlentherapie*, 1926, xxii, 667–688.

A statistical basis for forming a conclusion is not justified at present because insufficient time has elapsed. All that statistics tell us at present is that the operative procedure in mammary carcinoma leaves a certain proportion of patients uncured and that prophylactic postoperative irradiation may under circumstances not only be useless but even injurious. The results seem to show that the stronger the roentgen treatment the worse the outcome. It would seem that this is caused by an effect of the rays upon the healthy tissues and upon the general resistance of the body.

It is possible that a special technique of irradiation which seeks to avoid injury to the natural defenses may leave no grounds for criticism of the employment of postoperative irradiation. The author describes various forms of flanking irradiation of mammary carcinoma that may answer the requirements. It is, however, necessary to weigh the circumstances in each individual case carefully where the greatest danger of recurrence threatens and to adjust the method of irradiation to the requirements of the individual case. The author describes his technique in which the aim is to

attain the greatest biological effect with the least possible space dose and this can be established only when the radiologist is thoroughly acquainted with the clinical and biological findings in the individual case. It follows, therefore, that success is not to be expected without the closest collaboration between surgeon and radiologist. The author's experience with postoperative irradiation of mammary carcinoma is not yet completed but has been sufficiently encouraging to justify its continued trial. Uncritical after-irradiation without a satisfactory technique and without adequate biological considerations is condemned.

JÜNGLING, OTTO. Is prophylactic after-irradiation in mammary carcinoma justified? *Strahlentherapie*, 1926, xxii, 653–666.

A statistical analysis of results obtained in different clinics shows, as might be expected, a great variation in results. The use of roentgen rays in the Tübingen Clinic was apparently not effective and was possibly injurious. On the other hand, in the Kiel Clinic, the after-irradiation was certainly not injurious and was possibly, perhaps probably, of some use. The fact that in the clinics at Rostock and Hamburg the improvement in the three-year cures was only slightly or not at all maintained upon more prolonged observation deserves attention. Should these findings be confirmed they might suggest that under certain circumstances prophylactic after-irradiation results only in a prolongation of the period of recurrence.

It is emphasized that the results obtained at various centers have become worse with the increased modernization of technique and increase of the dose. A consideration of all the findings leads the author to state that the principle of the prophylactic after-irradiation in mammary carcinoma cannot by any means be regarded as a definite postulate. The procedure is even today entirely in the experimental stage, and it is certainly not a method to be employed in the small hospital. Continued methodical studies carried on for a number of years is necessary before the problem can be properly understood. Today, the same view may be taken as was held five years ago, namely, that prophylactic after-irradiation in mammary carcinoma will become of general value only when a fairly definite technique shall have been demonstrated in various localities to be harmless and definitely effective.

KEYES, EDWARD L. Recent radium treatment of bladder tumors. *J. Urol.*, February, 1927, xvii, 205–215.

During the past half year the author has implanted into a few bladder tumors radium emanation encased in metal capsules. The implantation when done suprapubically may be made almost or quite in the depths of the root of the tumor or in the bladder wall. This excites no bleeding, and if the projecting portions of the tumor are removed after ligature of the base, a clean wound is left, the suprapubic incision in the bladder may be sutured without drainage, and the patient may be dismissed from the hospital healed in two or three weeks. The author describes the technique and gives 8 case reports illustrating the vicissitudes of treatment. The immediate results are promising. The author's limited experience with the cystoscopic route for the application of emanation seeds has been trying and unsatisfactory because of seeds badly placed and seeds falling out. The cases treated by the suprapubic method are regarded as satisfactory. The technique of operation and treatment are given in detail.

LAZARUS, JOSEPH A. Deep roentgen therapy in disease of the prostate gland. *J. Urol.*, 1927, xvii, 37–52.

Urinary obstruction in adenoma of the prostate depends to a large extent upon the degree of edema of the mucosa of the prostatic urethra. Congestion and mucous membrane edema are important factors in prostatitis. Roentgen therapy is often a valuable palliative measure in the treatment of these conditions. In selected cases it is distinctly useful in treating "hypertrophy" of the prostate and cases of prostatitis. The good effects of roentgen therapy are dependent upon the ability of the radiation to reduce congestion. The rays do not sterilize an infected prostatic focus nor do they reduce the size of a prostatic tumor.

During the past four years the author has treated 19 patients with adenoma of the prostate and 10 patients with prostatitis. In the first group there were 2 cases with hematuria and the bleeding in both cases ceased after a single course of irradiations. The treatment advocated is divided into courses each consisting of exposures over four fields, namely, suprapubic, sacral, perineal and rectal. A full or half unit may be given at each exposure. If a full unit is given at one sitting only two treatments weekly can be given; but where a half unit dose is given, the patient returns every other day until a complete course is given. At the completion of the course he is told to return in six weeks at which time, should symptoms persist, a second course is instituted. Should there be no relief at the termination of the third course the patient is considered unsuited for this type of therapy and is advised to undergo a

suprapubic cystotomy under local anesthesia, regardless of the risks involved.

MUIR, JOSEPH. Irradiation of vesical neoplasms by removable platinum radon seeds: description of new instruments designed to facilitate their employment. *J. Urol.*, January, 1927, xvii, 53–60.

The scientific principles must be thoroughly grasped before the technique of implantation can be applied intelligently. The author has supplemented his "loading-slot" implanter to accommodate the new type of removable platinum radon seeds and illustrates briefly their use in the treatment of vesical new-growths.

PLATOU, E. S., and RIGLER, LEO. Roentgen-ray therapy in erysipelas. *Arch. Int. Med.*, Nov. 15, 1926, xxviii, 573–580.

The usual methods of treatment of erysipelas are distinctly unsatisfactory and accomplish little. On the other hand, roentgen-ray therapy applied to the affected part produces a rapid improvement in both the local and the systemic manifestations with a reduction of temperature to normal in from one to two days. In most of the cases treated by the authors only a single treatment of roentgen rays was given and no other form of therapy was used thereafter, except sedatives and analgesics.

The technique as finally evolved is as follows: The facial cases receive exposures over four areas, one anterior over the face and forehead, one on each lateral surface of the face and neck including the ear, and one on the scalp. The first three areas were always treated regardless of whether they were involved or not, in the hope of preventing a spread of the disease to normal areas. The area over the scalp was treated only when invasion or threatened invasion of it was in process. No protection was used except over the eyebrows. A distance of 10 inches from the tube to the skin of the patient was used over all areas with 2 mm. Al as filter. The rays were delivered at 111 kv. (peak) corresponding approximately to a 7 inch gap between moderately blunt points, and 5 ma. for five minutes over each area. Over the scalp, the dose was reduced to four minutes to avoid any possibility of causing permanent epilation. All the exposures were given at one sitting. In cases of erysipelas in other parts of the body the affected area, together with a large border of normal surrounding skin, was treated in the same way, the parts to be treated being divided into contiguous areas of approximately 300 sq. cm. The authors present summaries of 18 patients treated with iced magnesium sulphate and glycerin packs, the usual routine procedure, and of 23 cases treated by roentgen rays. The comparison is entirely in favor of the roentgen treatment.

Treatment with roentgen rays is an effective method for shortening the course and decreasing the morbidity and mortality in erysipelas. It is difficult to determine the actual cause of the beneficial effect noted. It appears reasonable to assume that it is due to some change in the circulation, possibly to a capillary effect.

SCHNEIDER, GEORG HEINRICH. On the temporary roentgen castration in inflammatory adnexal diseases with regard to dose and the influence of social relations. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 960–963.

The question of temporary sterilization of a woman depends primarily on the clinical indications prompting the roentgen treatment, because the radiosensitivity of the ovaries varies considerably in different disease conditions.

There are individuals of a certain social status whose actions tend to nullify the effects of a temporary roentgen amenorrhea for one of the following reasons: (1) the removal of the possibility of becoming pregnant is regarded as a signal for unlimited sexual activity; (2) in some, there appears to be no desire to be cured of their gonorrhea or to avoid a new infection, and the cost of treatment, etc., is left to the public health authorities; (3) others do not realize that their infection of the genitalia has not been treated by the roentgen irradiation, and they consequently neglect the important matter of continuing conservative therapy during the period of amenorrhea. In this group the underlying gonorrheal infection is neglected, and the resulting adnexal inflammation also remains untreated. These are the individuals who show a fresh lighting up of the inflammatory condition upon the first return of menstruation. There is still another class of women who are forced by circumstances to return to work immediately after irradiation, and who are unable to get proper attention and hold their jobs at the same time.

Individuals represented in the above groups will naturally show in statistics as failures or unsatisfactory results of the procedure of temporary castration as an aid in the treatment of inflammatory adnexal disease. It is, however, quite clear that such failures should not be charged to the method, for they are due to social and psychopathic conditions. These must be carefully excluded in forming an estimate of the value of the procedure.

An experience with several hundred cases shows that the dose for temporary roentgen

sterilization in inflammatory adnexal disease averages about 27.5 per cent of the skin erythema dose. This average value must be varied according to the age of the patient and the desired duration of amenorrhea.

Sgalitzer, Max. Recent advances in the field of roentgenization of brain tumors. *Strahlentherapie*, 1926, xxii, 701–708.

Roentgen irradiation of certain brain tumors causes a stop in the rise of intracranial pressure and regression of the most acute symptoms. These astonishing results which roentgen treatment often produces in inoperable brain tumors are not always due to a destruction of the tumor itself, but are due frequently to the mere disappearance of the internal hydrocephalus. This effect is produced by the secretion-inhibiting action of the roentgen rays upon the cells in the choroid plexus which produce the cerebrospinal fluid. As a consequence of this action, a decrease in the high intracranial pressure is made possible. Experiments on dogs carried out by Spiegel and the author show that roentgen irradiation of the brain produced pycnotic changes in the nuclei of the cells of the choroid plexus.

The author cites several cases. Roentgen treatment is recommended only in case of inoperable or unlocalizable brain tumors. The operable tumor should in all cases be treated surgically at the earliest possible moment. The irradiation should always be given in partial doses, no more than one field per day, in order to avoid a stormy early reaction which may become very threatening especially in tumors of the posterior cranial fossa with associated high pressure. The dose per skin field should at no time overstep the tolerance of the skin in order to permit a repetition of the treatment in about six to seven weeks. The most favorable prognosis appears to be given by gliomas.

Sisk, Ira R. Diverticulum of the bladder. *J. Urol.*, February, 1927, xvii, 255–258.

A report is given of an unusual case of diverticulum of the bladder in which the diverticulum at the time of operation did not communicate with the bladder. The diverticulum was of about 12 oz. capacity and was filled with thick pus containing *B. pyocyaneus*.

Two cystograms were taken twenty-four hours apart. The first showed a large distended bladder with a large indefinite shadow to the left and one or more small diverticula to the right of the bladder. As the shadow of the large diverticulum to the left was rather indefinite, the cystogram was repeated twenty-four hours later and the large diverticulum failed to show on the film. At operation it was found that the mouth of the diverticulum was entirely closed by inflammatory changes.

Szilárd, Paul. Studies on leukemia. II. Concerning the action of roentgen rays. *Am. J. M. Sc.*, March, 1927, clxxiii, 348–353.

White blood cells from healthy persons, suspended in the serum or plasma of irradiated leucemics decreased in number after twenty-four hours' incubation in the same proportion as before the irradiation. White blood cells of irradiated leucemics, suspended in their own serum or plasma, presented a very marked decrease, especially four hours after the exposure. After irradiation the cell decrease became progressively less with each test, and one month after the last exposure it had sunk to the same degree as before the treatment. However, the leucocytes of irradiated leucemics, suspended in the serum or plasma of healthy persons presented also a decrease of the same proportion as when suspended in their own serum or plasma. A study of the ameboid movement of the cells did not give any acceptable results. No specific autolysin was demonstrated by the complement fixation test.

The serum of irradiated leucemics injected into other leucemic patients of the same sex did not cause any decrease in the number of white cells. The amount of cholin did not increase either in the blood or in the urine of leucemics under roentgen-ray treatment.

From these observations the conclusion seems justified that no specific leucolysin or autolysin is produced in the leucemic organism under the influence of roentgen radiation. Consequently the effect of the rays in leucemia cannot be explained by this nor by a theory based on an increase in cholin. The experiments, however, show that the low resistance of the leucemic white blood cells is very definitely lowered still further by the roentgen treatment. This justifies the belief that the cell destruction is connected with a direct action of the rays. The effect of the roentgen ray upon distant organs or tissues not directly affected could perhaps be explained as due to electrons which invade the organism during exposure, and, circulating in the blood, reach all parts of the organism, exerting their deteriorating action upon the sensitive cells and tissues.

Walther, H. W. E. End results in genito-urinary cancer. *J. Urol.*, February, 1927, xvii, 179–197.

A report is given of 116 cases of genito-urinary cancer (not including malignancy of the kidney) observed at the Charity Hospital, New Orleans from 1921 to 1925 inclusive. There were 47 cases of cancer of the bladder, 31 of cancer

of the prostate, 30 cancer of the penis, and 8 cancer of the testis. The treatment employed included surgery, radium therapy, deep roentgen-ray treatment and electrocoagulation.

Cancer of the bladder was observed twice as often in males as in females and twice as often in whites as in negroes. Of 5 cases of cancer of the bladder which received radium treatment alone none survived. Four cases receiving combined cautery plus radium or high frequency plus radium fared better. The final results are given as follows for 47 cases of malignant cancer of the bladder: Dead, 17; improved, 9; apparently well, 7; indeterminate, 5; stationary, 4; growth not arrested, 2.

There were 10 cases of cancer of the prostate receiving radium treatment either alone or in combination with prostatectomy or punch operation. Four of these are living and still under observation. There were a total of 31 cases with cancer of the prostate and the end results are reported as follows: Dead, 19; improved, 4; stationary, 3; apparently well, 2; indeterminate, 2; metastasis, 1. There were 4 operative deaths.

Cancer of the penis was found three times as often in the negro as in the white. Of 6 cases which received radium alone, 3 are dead and 3 are improved. It would appear that the cases which received surgical care fared as well as those in which radium alone was used. Double inguinal adenectomy in conjunction with amputation gave encouraging results, as did the radium plus amputation. Where roentgen rays were substituted for radium, improvement was observed.

In cancer of the testis (8 cases) surgery was found to be as effective as either radium or roentgen rays. The details of the cases are given in tables.

WÄTJEN, J. On the pathology caused by irradiation. *Strahlentherapie*, 1926, xxii, 579.

This is a lecture concerning the general aspects of the subject and in which a discussion is given of the most important problems of modern radiation therapy considered from the standpoint of general pathology. It is pointed out that the whole problem cannot be adequately considered from any single viewpoint. Favorable clinical results are not always accompanied by a corresponding change in the histological picture, and as a result, the histologist is often too easily inclined to assume a skeptical attitude. Nevertheless the possibilities for the extension of radiation therapy through contributions from pathological anatomy are not to be limited by such considerations.

Anatomically demonstrable changes due to irradiation of the so-called endocrine glands occur in relatively small numbers and assume such contradictory aspects as to make it impossible as yet to serve as a reliable histological basis for experimental or clinical studies concerning the changes in function of these organs. Various examples are cited showing clearly the possibility of exerting an effect upon all tissues of the body by roentgen rays.

MISCELLANEOUS

BREITLÄNDER. A curved cassette for roentgenography. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 551–552.

A description is given of a cassette curved in the middle so as to place the ends at an angle of 135° to each other. This cassette permits the use of the double intensifying screens without breaking them and is especially valuable in securing sharper roentgenograms of the spine in kyphosis and of certain types of ankylosed joints.

BRUMMER, K. The electric charges of erythrocytes as the main factor underlying their sedimentability. *Strahlentherapie*, 1926, xxii, 322–326.

The rate of sedimentation of erythrocytes is governed only to a minor degree by thermodynamic forces as laid down by Stokes' law. On the other hand, the electrical charge of the erythrocytes is of major importance from this standpoint. When erythrocytes are deprived of their charges by means of roentgen rays they clump together in larger aggregates. This phenomenon of agglutination has been shown to be intimately related to the sedimentability of erythrocytes.

BURROWS, MONTROSE T., JORSTAD, L. H., and ERNST, E. C. The action of *x*-rays on the organism. *Proc. Soc. Exper. Biol. & Med.*, January, 1927, xxiv, 311–312.

A study was made of the effect of roentgen rays on animals fed on normal diets, diets deficient in either vitamines A or B, and diets balanced in these vitamines but deficient in other vitamines necessary for a normal existence. Carefully graded doses of roentgen rays were administered to the animals by Ernst's method. The results of these experiments show that the life of rats fed on a diet deficient in vitamine B is increased by giving 10 ma-min. (13 "e" units) of roentgen rays twice a week. This dose has no effect on rats fed on a diet deficient in vitamine A. Twenty-five and 50 ma-min. (34 "e" units and 68 "e" units, respectively) increase not only the length of life but also the growth of rats fed on both a minus A and a minus B diet, while larger doses, 75 and 100 ma-min. (102 "e" and 136 "e"

units, respectively) cause rapid deterioration and death of these animals.

It has long been known that many toxic substances show evidence of stimulation in small doses, and roentgen rays evidently belong in this class. Their action is one of molecular disintegration. In small doses the roentgen rays stimulate in regular sequences those molecular disintegrations which are the source of the normal energy for life. In larger doses they cause disintegration of the more important molecular constituents of the cell. It is also interesting to note that moderate doses of roentgen rays act very much the same as ultraviolet light in that they liberate vitamine A from tissues absorbing it so that this vitamine can be used by other tissues in the organism.

Chamberlain, W. Edward, and Dock, William. The study of the heart action with the roentgen cinematograph. *Radiology*, September, 1926, vii, 185–189.

A brief description is given of the machine devised by Ruggles and Fletcher of the University of California for cinematographic roentgenography of the human heart; and a method is described for analysing the motions of the heart from the films obtained.

The following information is obtained from these cardiograms. The normal left auricle empties early in diastole and shows only very slight motion at auricular systole. At the beginning of diastole the cephalic half of the normal left ventricular border may move mesad for as much as $^2/_{15}$ of a second after the apex has begun its diastolic excursion. The caudal 5 cm. of the normal right border moves in phase with the left ventricle. Only about 2 cm. of the cephalic part of the right border moves in phase with the auricle.

Files, Glenn W. The relation, radiographically of kilovolts peak to time of exposure. *Radiology*, September, 1926, vii, 255–256.

Occasionally a roentgenogram is made which is lacking in contrast, and it is desired to produce one with greater contrast. Ordinarily the time factor is increased with a corresponding reduction of the K. V. P. factor. The author presents a chart for assisting in determining what change in K. V. P. should be made to compensate for the change in time of exposure. The chart is based on practical work and on equipment which has been accurately calibrated with a sphere gap. Any desired milliamperage or distance may be used in employing the chart. The latter is, however, not applicable without the use of intensifying screens. Two examples illustrating the use of the chart are cited.

Gaertner, Otto. The importance of soft roentgen rays in irradiation experiments with bacteria. *Strahlentherapie*, 1926, xxii, 327–32.

It is well known that short roentgen rays appear to have no effect upon bacteria. To deliver a sufficiently large dose it is necessary to employ tubes capable of using at least 10 ma. By utilizing the longer wave lengths a greater proportion of the tube output can be employed. The author worked with an installation capable of delivering 50 ma. in connection with a specially constructed Müller tube provided with a copper anticathode and a Lindemann window. This tube was operated at 10 ma., 50 kv., effective. The average wave length of the unfiltered radiation was determined at a distance of 54 cm. from its penetration through 0.2 mm. Al and was found to be 1.29 Å. The bacteria were irradiated at a focal distance of 16 cm. The dose at this distance was computed at 36.3 to 36.8 R per second. A brief report is given on some preliminary experiments performed by Schepmann and Flecke who also performed some experiments at a focal distance of 8 cm. These observers found that a 10-minute irradiation (21,650 R) killed 100 per cent of *Bact. coli* and 75 per cent of staphylococci. Exposure for three minutes (6,500 R) produced 80 per cent reduction in *Bact. pyocyaneum*. These experiments indicate the feasibility of producing an effect upon bacteria by relatively short exposures to soft rays.

Glocker, R. International evaluation of protection against radiation. *Strahlentherapie*, 1926, xxii, 193–204.

The British Radiological Society has proposed through its X-ray and Radium Protection Committee the establishment of international rules on standard protection to be agreed upon at the next International Radiological Congress in Stockholm. For this purpose the radiological societies of the different countries have been invited to participate. As a basis for preliminary work the first and second reports of the X-ray and Radium Protection Committee are to be used. The author, representing the German Roentgen Society, reports and discusses the essential recommendations in the report of the British committee and recommends the agreement of the German Society in principle. A few changes are proposed. These are as follows:

Radiation Protection in Deep Therapy. When the roentgen tube is completely surrounded with a radiation-proof shell of material having a minimum lead equivalent of 4 mm. there is no necessity for a special protective housing of the installation. When the radiation table is provided with a minimum of 4 mm. of lead equiva-

lent on its under side there is present an adequate protection of the roentgen attendants provided the secondary rays escaping from the patient are screened off by a minimum of 2 mm. lead equivalent. A special protection of the surroundings of the therapy room by covering the walls, ceiling and floor is not necessary.

When employing tube holders with a protective power of less than 4 mm. lead equivalent or with an incompletely surrounded tube it is absolutely necessary to provide a protective housing, covering all sides with an at least 4 mm. lead equivalent and with the walls as far away from the tube as possible. Should there be permanently occupied rooms adjoining, above or below the roentgen room, it is necessary to provide a special protective layer on the walls, floor, or ceiling provided these partitions do not already furnish adequate protection. Lead glass windows should have a protective power corresponding to that of the floor and should be so inserted that no radiations will escape around the edges. Owing to the toxicity of lead, sheet lead walls should be covered over with paint or a wooden layer. The responsible head of the roentgen laboratory is specially cautioned to make a personal test (fluorescent screen observations with well rested eyes) on the adequate radiation protection of his employees. Any spot in which a fluorescence of the screen is observed must be avoided as dangerous.

Ventilation of Roentgen Rooms. Since nitrous gases are heavier than air, ventilators would be most suitably placed somewhere near the floor rather than near the ceiling of the roentgen room.

In addition to the above, the author makes certain recommendations regarding the revision of the 1913 regulations for radiation protection issued by the German Roentgen Society.

GREBE, L. The dynamic significance of the R unit. *Strahlentherapie*, 1926, xxii, 438–443.

The basis of the measurement of the R unit of roentgen rays is the measurement of the ionizing properties of the rays. It is pointed out that the ionization effect is a measure of the *impinging* roentgen rays. In contrast to this method of measurement is the method whereby the energy is directly determined in terms of calories, ergs, or watt-seconds. It is pointed out, however, that for purposes of practical dosimetry a direct measurement of the energy, or measurements based upon the unit of energy are impracticable.

The author determined by means of a bolometer built on the principle of Paalzow-Rubens the ergs per R corresponding to various roentgen wave lengths between 1.54 A and 0.21 A. For the former the value was 57.5 and for the latter 20,500 ergs per R. Calculation shows that within the range 1.5 to 0.5 A the formation of an ion pair by roentgen rays requires 21 volts and appears to be independent of the wave length. For wave lengths smaller than 0.5 A the energy per ion pair increases. From the standpoint of theoretical research on the effect of roentgen rays energy measurements are of the greatest importance.

The author's determinations show the relationship between the iontometric effect and the true radiant energy. Owing to the difficulty of determining the energy factor and its unwieldiness in actual use, the method will not find much application in practical dosimetry.

HAGLUND, PATRIK. On photographic marking of roentgen negatives. *Acta radiol.*, Oct. 15, 1926, v, 471–473.

Particular stress is laid on the value of marking photographic negatives, and the author believes that plates and films should also be signed. A description is given of the technique employed by the author in marking about 20,000 roentgen negatives since the opening of the Haglund private clinic in 1902.

The method of Arnell in which metallic letters, etc., are fixed to the film by means of adhesive plaster was found inadequate many years ago. By imbedding the desired metallic pieces in wax they are handled more easily and conveniently. With the wax at a suitable temperature one is able to fix the small plate containing the markings to the cassette even when the latter is held obliquely or vertically.

HALBERSTAEDTER, L., and SIMONS, ALB. Experimental observations on postoperative radiation treatment of malignant tumors as regards wound healing and prevention of local recurrences. *Acta radiol.*, December 15, 1926, v, 501–505.

In a number of cases rather large open wound surfaces resulting from diathermy operations of carcinoma were subjected to postoperative roentgenization in such a manner that only half the wound area was exposed to the rays, the remainder being protected by lead. It was found that there occurred a definite delay in wound healing in the irradiated areas, the resulting scars, however, being as a rule in sounder condition than in the non-roentgenized portions. In one case after the lapse of a month the non-irradiated area of the wound showed numerous recurrent foci while the irradiated portion was free of recurrences.

It is concluded from these observations that there is not only justification for postoperative roentgen treatment but a definite necessity for it.

HOPMANN, W. Practical improvement of the Bucky roentgenographic table. *Fortschr. a. d. Geb. d. Röntgenstrahlen.* April, 1926, XXXIV, 553.

The improvement consists in the introduction of a hinge for the tube support so that the latter may be swung out of position until the patient is properly placed and then swung back in correct position.

JACOBY, PAUL. Measurements by means of the Siemens' dosimeter and the Sabouraud pastille, and by the former in connection with a tube of Sabouraud paper. *Acta radiol.*, Aug. 30, 1926, V, 333–371.

An attempt is made to surmount some of the difficulties and answer some of the questions with which the roentgen operator is faced whenever the substitution of a new and more powerful therapy apparatus for one of lower power obliges him to re-establish his entire scheme of exposure times to fit the altered conditions. The author's measurements were made by means of a Siemens dosimeter and the Sabouraud pastille and by means of the dosimeter in connection with a tube of barium platinocyanide, the latter being fitted over the ionization chamber.

The more powerful apparatus, of course, permits an enormous shortening of the exposure time for the production of a skin erythema dose; on the other hand, with voltages above 100 or 120 kv. its use does not result in any appreciable further increase of the penetration percentage. The limitations of the various measuring devices are discussed and particularly the important disadvantage inherent in all that there is no means by which the indications for the different qualities of radiation can be compared; the Sabouraud pastille especially and its alleged deficiencies are gone into exhaustively.

One chief objection to the pastille is based on the fact that at certain wave lengths, its own characteristic radiation causes it to color too quickly. The author therefore made some further studies concerning the absorption in the pastille itself by measuring by means of the dosimeter how much of the intensity of the radiation became diminished when the ionization chamber was entirely covered by a tube of Sabouraud pastille paper. This absorption was measured at increasing tensions from 60 to 80 kv., and also under various conditions of increased filtration at different voltages. It was found that there is a perfectly gradual decrease in the absorption following filtration with from 1 mm. to 8 mm. Al and 0.5 mm. Cu plus 1 mm. Al, the last named combination corresponding to 11 or 12 mm. Al. The author was thus unable to find any break in the absorption which might be explained as due to the characteristic radiation of the pastille.

It is assumed that the erythema dose is the product of time and intensity of radiation times percentage of radiation which is absorbed by the skin. If it were possible to determine the value of each of these factors separately, it would be possible to figure out the correct exposure time for a different quality of radiation. The author makes the assumption that the absorption in a pastille paper tube measured as above indicated is parallel with the absorption in the skin and that the ionization current is the expression of the surface intensity on the skin. On this basis an attempt is made by means of a simple equation to find the correct exposure time for 1 S. E. D. under various conditions of intensity of radiation. Practical tests in which the exposure times for 1 S. E. D. had previously been determined empirically seem to prove the correctness of these theoretical conclusions.

Practical experiences with the erythema dose prove the latter to be somewhat different for different individuals; and it has been observed also that the reaction of the skin becomes unexpectedly strong under short time exposure with higher intensity. The author attempts to account for these phenomena. Numerous measurements were made both on the water and paraffin phantom under all the different conditions of radiation employed in the roentgen department of the Frederiksberg Hospital, Copenhagen. These measurements are recorded on celluloid working charts by means of which it is possible to establish exact plans for the dosage in any case.

KNUDSON, ARTHUR, and COOLIDGE, W. D. Effect of high voltage cathode rays on rickets and on the activation of cholesterol. *Proc. Soc. Exper. Biol. & Med.*, January, 1927, XXIV, 366–369.

Recently Coolidge has developed a means for producing high voltage cathode rays outside of the generating tube. It seemed of interest to study the effects of these rays upon experimental rickets in rats, first, when applied directly, and second when used for the activation of cholesterol. The animals were put on a rachitic diet and after four weeks showed advanced rickets, as evidenced by roentgenographic examination. Various exposures of the rachitic rats to the cathode rays were tried but in only one case was the slightest evidence of healing observed. The conclusion seems justified that with potentials of 100, 200 and 350 kv., rickets in rats cannot be cured by direct treatment with cathode rays. This failure is presumably to

be explained by the fact that the rays produce such severe damage to the animal that it is not possible to give a dose necessary to activate enough of the cholesterol in the skin to bring about the desired result.

Experiments were carried out to ascertain whether cholesterol could be endowed with antirachitic potency by exposure to these cathode rays. The cholesterol was evenly distributed over the inner surface of a petri dish and was then exposed to the cathode rays at a distance of 1 inch, at 200 kv. and 1 ma. This activated cholesterol when fed to rachitic rats produced healing. It was found that cathode rays themselves do not interfere with the healing of rickets initiated by exposure to ultraviolet light.

Kroetz, Ch. Effect on tissue by roentgen rays. *Strahlentherapie*, 1926, xxii, 319–321.

The variations in blood composition after irradiation may be regarded as an index of changes produced in the tissues. The changes noted are in protein distribution and in the mineral content. These effects may be due to an action upon the cell membrane, on the tissue fluids and on the protein.

The permeability of the cell membrane as affected by the rays was studied in the surviving frog skin which shows an irreversible permeability to salts, sugars and dyes. Experiments have shown that after irradiation, the skin permits an outflow of sodium chloride only, which is in agreement with well-known biological observations. The irradiated skin showed no altered permeability to protein or acid and basic dyes.

Observations on the alterations produced in tissue fluids by irradiation were made in rabbits and guinea pigs. Saline or other solutions were infused into one of the body cavities and after irradiation were examined for various constituents. These examinations confirm the findings made in the blood of irradiated animals. There was breakdown of protein, an increased permeability of the vascular system, and an altered transport of minerals.

Concerning the relation between protein breakdown and alteration in mineral composition it was found that a similar phenomenon could be duplicated *in vitro*. The ultrafiltrate of irradiated serums showed a slight but distinct increase in sodium and potassium and a slight decrease in calcium, while chlorides and phosphates remained unchanged. This may be due to a loosening of chemical bonds or an adsorption phenomenon. Irradiation with small doses produces increase in albumins and decrease in globulins but large doses of rays cause increase in globulin and decrease in albumin, and at the same time there is an alteration in the pseudo- and euglobulin components. No increase in amino acids as a result of irradiation could be demonstrated.

Kulenkampff, Helmuth. Comparative studies on the energy and air-ionizing action of roentgen rays of different wave lengths. *Ann. Physik*, 1926, lxxix, 97–142.

When the energy of roentgen rays is measured by their ionizing action, the energy is equal to the product of the number of ions formed and the energy consumed in forming an ion pair. In the present studies, a sensitive thermopile was used to measure the fraction of energy of the $K\alpha$ radiation dissipated as heat from anticathodes of silver, molybdenum, iron, platinum and copper. The spectral composition of the rays was determined with an ionization spectrometer. The absorptive power was found to vary as the third power of the intensity. From the measurement, a value of 35 ± 5 volts per ion pair was found as the energy consumed in producing the pair and this value is apparently independent of the wave length for the range 0.56 to 2 A.

Liechti, Adolf. The importance of beta rays in the biological effect of roentgen rays. *Acta radiol.*, Oct. 15, 1926, v, 385–394.

By experiments with secondary rays produced from metal plates and metal colloids upon *B. prodigiosus* and upon the skin and testicles of the rabbit, it has been found that no increase of the dosage to any practical extent is to be expected from the secondary rays and that the secondary beta rays are of decisive importance for the efficacy of the roentgen rays. This circumstance suggests that the roentgen rays probably produce a membrane effect; and this probability is supported, among others, by experiments upon current-producing electrolytic chains which showed that by exposure to roentgen rays the potential difference between oil and glass chains is increased, whereas the e.m.f. in the case of a membrane of copper-ferrocyanide and a non-desiccated collodion membrane under free diffusion of water remains unaffected. The hydrogen ion concentration of the subcutaneous tissue fluids increases after roentgen irradiation. Theoretically this agrees with the filter theory of Michaelis concerning semipermeable membranes, according to which their permeability for cations becomes increased through the negative charge at the cell boundaries.

Lundqvist, Arvid. An iris diaphragm suitable for roentgen diagnosis. *Acta radiol.*, December 15, 1926, v, 571–574.

The author recommends the employment of an iris diaphragm in combination with a

cylinder for roentgen diagnosis instead of the usual cylinder or cone with removable diaphragms of fixed size. The iris diaphragm with its variable opening may be used under all conditions.

Mertz, Albrecht. Increase in serum enzymes after light and roentgen irradiations, an index of cell catabolism. *Strahlentherapie*, 1926, xxii, 301–318.

By demonstrating an increased serum titer of an enzyme, liberated in the course of cell breakdown, the author shows that therapeutic irradiations with light and roentgen rays cause such a cell breakdown. The procedure involved the demonstration of a peptidase capable of splitting the dipeptide glycyltryptophane. The concentration of this enzyme varies between individuals but remains fairly constant for a day or two in the healthy individual.

This peptolytic index was determined in the serum and urine of individuals irradiated with artificial sunlight or roentgen rays. In general the increase in peptolytic index was greatest after the first irradiation. In the case of sunlight treatment it was found that the high index was maintained even after definite pigmentation had occurred.

As was expected, the effects of roentgen irradiations were much more pronounced than the light treatments. A very light and localized irradiation of a small skin area with about $\frac{1}{5}$ the erythema dose caused a prompt increase in the peptolytic index. With doses such as are employed in menorrhagia the response is of course much greater but not at all in proportion to the increase in dose. This is accounted for by the hypothesis that the peptidase is sensitive to high acidity and that a portion of the enzyme may have been destroyed in the tissues acidified by the larger dose; perhaps, also, a portion of the enzyme may have been excreted through the kidneys. The author believes that the increased peptolytic index found demonstrates increased cell catabolism, and the method employed is a suitable test for showing this breakdown and the transfer of the products to the blood. This method may perhaps find employment in determining which wave lengths are most effective from the standpoint of hardness and filtration, and especially in the question of the significance of the general distant effects of irradiation including also roentgen sickness.

Muir, Joseph. Radio-active substances: Their therapeutic uses and applications. *Radiology*, September, 1926, vii, 242–248.

A review is given of the aspects of radium treatment of pathologic conditions of the tonsil.

The chief point in the therapy of tumor growths commonly found in the tonsil when radiation is to be the agent employed is that the radiation should be adequate not only to reach the actively malignant tissue but also the surrounding potentially malignant zone. The most satisfactory means of accomplishing this so far has been the implantation of small centers of radioactivity, placed at intervals about the periphery of the growth as well as through the center.

When such a tonsil lesion is seen early enough to apply this treatment before cervical metastases have taken place the chances of complete eradication are very good.

Odqvist, Henning. A device for the exact placing and fixation of the head in skiagraphy, with particular reference to the examination of the accessory nasal cavities. *Acta radiol.*, December 15, 1926, v, 565–570.

The author describes a device for placing and fixing the head with particular reference to the roentgen examination of the accessory nasal cavities. The apparatus may also be used for obtaining identical, oblique lateral positions of the cranium. The device is based on the assumption that each external auditory meatus is symmetrically situated and enables these to be placed in the same horizontal plane and thus the sagittal axis of the cranium may be exactly determined. From this initial position the cranium may then be rotated to the right or the left along a circular scale. The device is pictured and the method of use indicated.

Quimby, Edith H. A method for the study of scattered and secondary radiation in x-ray and radium laboratories. *Radiology*, September, 1926, vii, 211–217.

Since the radiologist is exposed to radiations which may vary considerably from time to time an accurate measurement of one hour's or even one week's exposure may give false ideas as to the quantity received over a long period. Measurements in one or several definite parts of a room do not adequately represent the exposure of the technician. A roentgen film worn or carried by the worker gives a cumulative record of the radiation it receives. Repeated tests of this sort should give accurate information regarding the radiation received by any one worker.

A method is described by which (with the aid of a simple apparatus) the density of the film is accurately measured and the amount of radiation necessary to cause such darkening may be calculated in terms of the skin erythema dose. The method depends upon the comparison of test films with films exposed to known

quantities of radiation, the density measurements being made by means of a photoelectric photometer. This method does not measure the total amount of radiation received, although it affords a basis of calculating this if desired. It does give a direct measurement of the radiation to which the worker is exposed; but the radiation quality determines how much of this radiation is absorbed by the tissues.

The discussion in this paper is limited to the effects of radium radiations. The method is equally applicable to roentgen rays. It is probable that radium standard films could be used to measure roentgen-ray exposures since the density of the film is independent of the quality of the radiation over a fairly large range; but this point remains to be tested experimentally.

Rekling, Eigil. Investigations concerning the photoactivity of certain oils, with special reference to their antirachitic effect. *Acta radiol.*, December 15, 1926, v, 517–532.

The author sought to determine whether there exists any difference between the photoactive properties of cod liver oil and those of vegetable oils and if so, to develop a working hypothesis to explain the spontaneous antirachitic action of the former as opposed to the corresponding effect of the latter which is only acquired as a result of ultraviolet irradiation. A study was also made of the conditions determining the acquisition of photographic activity by ultraviolet irradiated oils.

Cod liver oil was always found to affect a photographic plate, whereas this property was absent in linseed and olive oils. The cod liver oil when left to stand for a certain period in complete darkness or in semi-obscurity develops a corresponding medium or very intense plate-darkening power while linseed oil under similar conditions becomes only slightly active, and olive oil remains inactive. Ultraviolet irradiation of these three oils under identical conditions produces a much stronger photoactivity in the cod liver oil than in the other two.

From the vegetable oils the photoactive agent can be removed completely by forcing air through the oil, whereas this property is removed only partially by similar treatment of cod liver oil. If the ultraviolet irradiation has been prolonged subsequent aeration will not destroy the photoactivity. Cod liver oil apparently demands less additional ultraviolet irradiation for it to retain its full photoactive power. When the irradiation is performed with the oil in an atmosphere of nitrogen, carbon dioxide, or hydrogen, the amount of photoactivation of the oils is practically negligible. The presence of oxygen during the irradiation is a necessary condition for the generation of photoactivity in the oils.

The photoactive agent can be transferred to a fresh oil from an active one by having a current of air from the latter pass through the former. The fresh oil will then become photoactive. There is no ionization in connection with the photoactivity of the oils. The presence of hydrogen peroxide in the active oils has been demonstrated, and a consideration of all the effects leads to the conclusion that the photoactivity of the substances in question is due chiefly to the formation of hydrogen peroxide, an oxidative change initiated or accelerated by ultraviolet irradiation.

Experiments on rats maintained on a rickets producing diet did not reveal any apparent parallelism between photoactivity and antirachitic potency in the oils. The photoactivity of the oils may be regarded as an indicator of the fact that cod liver oil is a substance which is in continual strong activity and reacts to irradiation more easily than either linseed or olive oil. Apparently the cod liver oil contains some light-sensitive catalyzer or photodynamic substance in which even ordinary daylight readily initiates antirachitic properties and that the lack of some such photodynamic sensitizer may possibly account for the genesis of rickets in the young.

Sievert, Rolf M. A circulating physical department for standardising the roentgen radiation used in therapy. *Acta radiol.*, Oct. 15, 1926, v, 457–467.

A description is given of a department designed to visit roentgen laboratories throughout the country in order to examine the roentgen apparatus and tubes in use and to standardize the dosage. A department of this kind has been established in conjunction with the physical laboratory of Radiumhemmet, Stockholm, and has been in operation for six months, apparently fulfilling a long felt want.

The tests made by this unit may be classified under two heads: (1) those factors which do not bear upon the determination of the radiation but only upon the control of the apparatus and the economy of operation. In this connection the following factors are studied: (*a*) consumption of current; (*b*) variations of primary voltage and their effect on the total radiation; (*c*) the fineness of regulation of voltage and milliamperage; (*d*) the reliability of the milliammeter; (*e*) the reliability of the kilovoltmeter; (*f*) filter; (*g*) presence of high frequency intensities; (*h*) durability and suitability of the roentgen tubes. The second aspect of the studies is that concerning those factors which

determine radiation and which should always be constant so far as possible. For every filter and voltage used these are: qualitative: (*a*) the peak voltage, and (*b*) the voltage curve or roentgen spectrum and deep dosage; quantitative: (*a*) milliamperage, and (*b*) the ionizing power of the radiation.

The author proposes that the standardization shall be extended not only to questions of dosage but also to several other factors with the object of producing uniformity in statistics.

Sievert, Rolf M. A simple, reliable device for the measurement of depth doses. *Acta radiol.*, Oct. 15, 1926, v, 468–470.

The author describes an instrument for measuring depth doses which consists of two ionization chambers provided with condenser and a Wulf electrometer. The ionization chambers are entirely detached from the electrometer and are placed on the latter after having been exposed to the roentgen radiation under test.

Spolverini, Luigi. The effect of ultraviolet rays on growth. *Radiol. med.*, December, 1926, xiii, 861–873.

Spolverini describes the experimental results obtained by irradiating rats with ultraviolet rays for different periods of time and with varying technique. He concludes that the best effect on development and growth in young rats on the use of artificial ultraviolet rays is obtained by exposure to the rays for 2 minutes every forty-eight hours at a distance of 50 cm. Daily exposure is generally injurious and so is exposure at a distance of less than 40 cm. Exposure for 4–6 minutes at a distance of 50 cm. even when given every other day is not so effective as exposure for only 2 minutes.

From what is known at present it seems to be advisable to expose healthy and prematurely born infants to ultraviolet rays for the purpose of promoting growth; the exposure should be for 2–3 minutes every other day or 4 minutes at the maximum at a distance of 60–70 cm. from the source of light but it should never be continued long enough to produce erythema.

Stenström, Nils G., and Westermark, Nils. A study of the activity of the human heart, simultaneously recorded by *x*-rays and electrocardiogram. *Acta radiol.*, Oct. 15, 1926, v, 408–418.

The inductive disturbance caused by roentgen-ray machinery in the string-galvanometer circuit can be compensated by inducing in the latter an opposite electrical current of the same period and strength. Following this principle, the authors have succeeded in producing useful electrocardiograms during the roentgenographic exposure. The movements of different points of the heart boundary have been photographed through a slit upon a falling plate, generally two points at the same time, and the curves were then compared with the electrocardiograms obtained simultaneously. The authors give a preliminary report of the results of their technique.

The curves are probably caused by contraction of the heart border and also the pushing and traction from other portions of the heart. The curves from the upper and back part of the right border are most probably caused by the ventricle pushing the auricle to the right. The different points of the border of the heart give different curves, each point having its own characteristic curve. The interval between the electrocardiogram and the chief summit of the roentgen-ray curve is constant for any definite point but changes from point to point. Two minima for this interval are found, one on the right and the other on the left ventricle in the apical region. The effect on the curve by the contraction of the right auricle is usually perceptible but is not very marked. The left ventricular curve is the most complex one, being made up of a series of peaks all but one of which being caused probably by indirect pushing and traction from other parts of the heart.

Stilgebauer, Otto. A new roentgenographic table with built-in Bucky diaphragm, horizontally and vertically adjustable. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 539–540.

A brief description is given with three illustrations of the table. The table top has four removable sections, and the Bucky diaphragm may be slid from the middle to the head of the table and then adjusted vertically so as to permit the taking of roentgenograms of the abdominal or upper regions of the body.

Viethen, A. An improved supporting bench for infants during roentgenoscopy. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 554.

The device described incorporates the good features of the Wimberger apparatus with the addition of a strap that prevents excessive movement of the child's head during the roentgenoscopic examination. By means of suitably placed cross pieces the arms are kept away from the body, and feet are kept down by means of a rubber strap.

ten Doornkaat Koolman, Menna. Experimental studies on the effects of roentgen

rays upon erythrocytes. *Strahlentherapie*, 1926, xxi, 668–680.

Experiments were performed upon several dogs. The radius or tibia was opened and a specimen of the marrow was removed for examination. After the wound was sewed up the other normal limb was irradiated over a length of 15 cm. at a focal skin distance of 25 cm. through 0.5 mm. Zn plus 3.0 mm. Al for ten minutes, with $\frac{1}{3}$ of a skin erythema dose (equal to 200 R). The irradiations were repeated two or three times. The operation was then repeated and bone marrow was removed from the irradiated bone for cytologic study. The irradiations were controlled by the blood picture.

It was found that the marrow before irradiation showed the usual red blood cells, occasional erythroblasts, megakaryocytes, polykaryocytes, myelocytes, myeloblasts, leucocytes and leuycoctes with lobulated nuclei. After irradiation, the marrow from the irradiated bone showed very numerous erythroblasts, myeloblasts, myelocytes, metamyelocytes, megakaryocytes, connective tissue mast cells, plasma cells. The marrow from the non-irradiated bone after irradiation of the animal showed very numerous erythroblasts, megakaryocytes, polykaryocytes, myeloblasts, myelocytes, eosinophil myelocytes, and leucocytes.

In the non-irradiated animal, the marrow after the first operation showed occasional erythroblasts together with cells belonging to the white cell group. In the marrow after the second operation there was an increase in erythroblasts in the bone that had previously been operated upon; and in the bone which had not been previously operated upon, there was only a slight increase in erythrocytes above the normal, but not nearly so great as in the marrow of the operated bone.

These experiments show that the first operation for securing a marrow specimen, by causing a slight increase in the erythroblasts, may throw a doubt on the effectiveness of roentgen irradiation in producing this change. The experiments were consequently repeated except that the initial operation for securing normal bone marrow was omitted. The results in this case confirmed the original experiments and demonstrated quite completely that the roentgen rays stimulated a production of red cells directly in the bone marrow. No success was obtained even in experiments upon very young animals in producing a direct effect upon the erythrocytes, but it was clearly shown that roentgen rays in doses of one skin erythema dose produce a decided effect on the erythropoietic system.

Todtenhaupt, W. A peculiar development of roentgen ulcer. *Strahlentherapie*, 1926, xxii, 191–192.

A case is reported in a woman fifty-three years old suffering from gastric symptoms, who was subjected to eight roentgenoscopic examinations during a period of five days. A month later she received an insect bite in the region of the upper sacrum following which there developed numerous pustules and necrotization of the skin. The ulcer healed in four weeks with development of a scaly scar tissue. The patient was readmitted a year or more later for stomach complaint, and in the region of the sacrum there was seen a scarred area of the skin about the size of a saucer still showing mild scaling and pronounced telangiectasis. This condition was still present four years after the original roentgenoscopic examinations.

Apparently in this case the tissue alterations due to the insect bite may have had something to do with the ulcer formation. There may perhaps also have been an individual roentgen hypersensitiveness. It may be mentioned that no such skin changes have been observed in other cases subjected to gastrointestinal roentgenoscopy. Similar observations do not appear to have been mentioned in the literature.

Wagner, G. A., and Schoenhof, Clara. Experimental and histologic studies on the mechanism of the action of minimal doses of roentgen rays upon the female reproductive glands in humans. *Strahlentherapie*, 1926, xxii, 125–140.

Although it is not possible to inhibit the function of a follicular cyst which has already produced metrorrhagia and the resulting uterine hemorrhages cannot be stopped by a mere extirpation of the cyst, the bleedings can be positively controlled by roentgen irradiations. These facts cannot be harmonized as yet; it is quite permissible to regard ovaries having cystic degeneration of the follicles or the follicular system as the underlying cause of true hyperfunctional disturbances, which may be followed by proliferation and pathological increase of the specific hormones such as we find in the thyroid in Basedow's disease and in the hypophysis in acromegaly. This, however, does not justify the drawing of parallels between disturbed ovarian function and the altered functions of other endocrine glands.

The authors sought to determine the effects of minimal roentgen doses on the ovaries by applying $\frac{1}{4}$ to $\frac{1}{10}$ of a castration dose to one ovary in women who were to be operated on for other conditions and in whom no pathological

conditions in the ovaries could be demonstrated. The second ovary was carefully protected. The radiation was administered with a Coolidge tube, 160 to 180 kv., 0.5 mm. Zn plus 0.5 mm. Al, the percentage dose at a depth of 10 cm. at a focal skin distance of 23 cm. being about 15 per cent. This clinically stimulative dose was applied, and the women were then operated upon at different intervals after irradiation (from one day to several weeks) and histological specimens from each of the ovaries were removed. A total of 38 cases was thus observed and in none of the irradiated ovaries was there discovered any typical or uniform set of changes that could be regarded as due to a destructive action by these minute irradiations. Oftentimes degenerative changes were found in the ripening or primary follicles and now and then there were observed pronounced proliferations of the theca in atresic follicles, but these changes were no more frequent in the irradiated than in the control ovary in the same individual. However, it is also to be noted that in no case was there seen histologically any increase in development in the irradiated ovary. Frequently the impression was obtained that there were more follicles at the same stage of ripening in the irradiated ovary as compared with the control. It is pointed out that these experiments were made upon normal ovaries and that one may not be justified in drawing conclusions from these as to the effects of irradiations upon the hypofunctioning ovary. Moreover, the histological method of study may not be entirely satisfactory for demonstrating the effects produced by irradiation.

Weber, E., and Brezina, O. Experimental determination of permissible displacement of the object during exposure; and a method for determining the necessary exposure time and efficiency of apparatus and tubes for a variety of different roentgenographic problems. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, April, 1926, xxxiv, 543–546.

Employing as test object the trabeculae of the spongiosa in a human lumbar vertebra with the rays directed craniocaudally and a 1 mm. lead wire which could be shifted across the screen, it was found that the greatest permissible degree of displacement is 0.2 mm. at an average object plate distance of 60 cm. This shows that no matter how complicated the fixing arrangement may be, voluntary movements on the part of the patient are sufficient to disturb the roentgenographic detail. This means that complete coöperation by the patient must be secured or else narcosis must be resorted to. The other alternative is of course the reduction in the time of exposure.

Knowing the permissible displacement, it becomes a relatively easy problem to calculate the maximum time of exposure capable of giving clear roentgenograms undisturbed by automatic movements of the organs in the body. For roentgenographing the heart during systole, it is calculated that an exposure of $^1/_{100}$ of a second will be satisfactory in the case of a pulse rate of 55 with a systolic period of 0.34 second and 6 mm. displacement of the left ventricular wall. In the case of a high pulse rate of small amplitude and a systolic period of 0.2 second the time of exposure may be $^2/_{100}$ of a second. Since diastole is slower than systole, the above exposure times apply also to roentgenography during diastole.

In order to get sharp pictures of the lung markings, teleroentgenograms should be taken of the thorax with a sufficiently short exposure time. Under normal conditions an exposure of $^1/_{20}$ to $^1/_{25}$ of a second will be ample. Where there is a pronounced cardiopulsatory movement of the lung, the exposure times recommended for heart roentgenograms will have to be employed. Where respiratory movements have to be taken into account also, as in the case of small children, the data above given permit the calculation of the exposure time which varies from $^1/_{25}$ to $^1/_{100}$ of a second depending on the number of respirations and their depth.

An approximation formula is given which is adequate for practical purposes in determining the necessary exposure time E_2 for changed focal plate distance of the object and greater milliampere-voltage from the known exposure time and factors. This formula is:

$$E_2 = E_1 \frac{ma_1 \times kv_1^4 \times D_2^2}{ma_2 \times kv_2^4 \times D_1^2}$$

In this equation E_1 is the given exposure time, ma_1 the milliamperage in the first case, ma_2 the maximum milliampere capacity of apparatus and tube, kv_1 and kv_2 the respective potentials at the tubes and D_1 and D_2 the corresponding focal plate distances.

Wintz, H., and Rump, W. The roentgen photometer. *Strahlentherapie*, 1926, xxii, 444–450.

A description is given of an instrument which is claimed to be a distinct advance in the field of roentgen dosimetry. The roentgen rays are passed through a filter and impinge on a fluorescent screen so that the emitted fluorescence converges through a Lummer-Brodhun prism to the eye of the observer. This fluorescence is matched with light from a standard source filtered through a green screen. The instrument has been compared with ionization dosimeters and found to be more advantageous in the

water phantom because the shadow of the lead-coated conductors to the chamber is eliminated and further because scattered radiation is practically uniform from all sides and can therefore be measured. As a consequence the new instrument shows 10 to 15 per cent higher readings than are shown by ionization methods.

The new instrument may be calibrated in terms of R units or skin erythema dose. A proportionality with the roentgen-ray energy at various wave lengths is not shown by the new instrument any more than by the older ionization methods. Nevertheless the roentgen photometer possesses the advantage over ionization instruments in that its readings for radiations used in deep therapy parallel the biological effect. When once the instrument is calibrated biologically one need no longer consider the ray quality in dosing. Other advantages claimed for the roentgen photometer are portability and independence of external conditions such as humidity, barometer, etc.

WINTZ, H., and RUMP, W. The biological effects of various roentgen-ray qualities. *Strahlentherapie*, 1926, xxii, 451–459.

When the dose is determined by the ionization method the data show that soft rays are more effective than hard. Consequently to produce comparable biological effects the R doses must be varied according to the ray quality. Values of radiation quality based upon degrees of radiation passing through a filter or upon the calculation of an average wave length, etc., are not specific since they vary with the measuring device employed. Until spectrographic methods are developed for this purpose one must remain content with the calculation of the radiation quality from the voltage, filtration and type of apparatus.

Owing to the dependence of the radiation quality upon the particular type of dose meter the increment of scattered radiation will be found to vary with the instrument used. From the standpoint of uniformity in dosage this can be corrected by the introduction of a standard correction for scattering determined in practice. The scattered radiation of air is about 0.5 per cent of the primary radiation.

WUCHERPFENNIG, V. The effect of the dose in superficial roentgen therapy due to variations in the line voltage. *Strahlentherapie*, 1926, xxii, 172–183.

A test was made upon apparatus employed for superficial therapy to determine the relationship of the roentgen dose to the line voltage. It was found that the roentgen dose does not decrease in the same proportion as the line voltage. With unfiltered rays the ratio of voltage decrease to dose decrease was 1:2, and with 2 mm. Al filtration the ratio was 1:3.

This is explained by the fact that with decreasing voltage and a constant tube current and filtration the total intensity of the spectrum decreases, the short wave end of the spectrum and the intensity maximum tend to shift toward the longer wave lengths, and primarily because of the fact that there is a considerable diminution in the radiation from the range of longer wave lengths.

The possible change in dose through variations in line voltage is much greater for skin therapy than for deep therapy owing to the fact that the period of the variations may continue for the total exposure time of the skin treatment; whereas in deep therapy, the considerably longer treatments required tend to average the fluctuations in line voltage so that the final dose delivered approximates fairly closely the intended dose. If in the course of a skin treatment there should occur a simultaneous overloading of the line voltage, the dose delivered might well exceed to a dangerous degree the intended dose.

The author describes a circuit which permits, through the adjustment of a simple slide rheostat, the maintenance of the tube current (of the milliammeter) and which also enables the voltage to be maintained at a constant level.

ALLEN, EDGAR V., BOWING, HARRY H., and ROWNTREE, LEONARD G. The use of radium in internal medicine. *J. Am. M. Ass.*, Jan. 15, 1927, lxxxviii, 164–168.

The use of radium chloride in doses of 10 to 50 micrograms has not been attended by toxic manifestations. In 25 cases of carefully controlled hypertension, treatment by radium chloride intravenously did not yield sufficiently favorable results to encourage its further use. Following the injection, a transient fall of pressure was observed similar to that following the use of sodium nitrite or phenobarbital. In 2 cases there was a slight response which persisted during the period of observation. Radium chloride was used intravenously to relieve pain 39 times in 28 cases. A gratifying effect was obtained in thrombo-angiitis obliterans and to a less extent in diabetic neuritis. In a miscellaneous group consisting of endarteritis obliterans, neuritis, arthritis, and puritus vulvae, the relief was not sufficient to warrant continuation of the treatment. The best results were obtained in the relief of pain in thrombo-angiitis obliterans, but even in this condition radium therapy has been replaced by treat-

ment with nonspecific vaccines which yield even greater relief.

From these observations (made at the Mayo Clinic) it is concluded that radium chloride sometimes lowers blood pressure, occasionally quite markedly, but the same results can easily be obtained by other and simpler methods. Radium chloride relieves pain; and the relief is occasionally marked, but the same results can usually be obtained by other and less costly measures. While qualitatively radium may relieve pain and reduce blood pressure the results quantitatively usually fall far short of success.

The use of radium in these conditions is justifiable provided commoner methods have failed, but even when so used the results in the authors' experience have usually been disappointing in the end.

Beets, H. N. Barium plaster x-ray protective walls for roentgen laboratories. *Radiology*, October, 1926, vii, 340–341.

Available information regarding the value of barium plaster walls is conflicting; and some comparative tests as to the relative value of barium walls and lead walls were made by the author. Of various samples of barium plaster walls made and tested only one type proved successful. This plaster was made of one part barium sulphate, one part Portland cement and two parts of barium sulphate sand (crushed barium rock). It was found that less than 0.5 inch of barium plaster fails to act as a homogeneous filter and cannot be said to have any definite lead equivalent; 0.75 inch barium plaster is equivalent at roentgenographic voltages (8 inch gap) to approximately $^{1}/_{16}$ inch metallic lead; at therapeutic voltages (200 kv.) 2 inches of barium plaster, weighing 30 lb. to the square foot is equivalent to approximately $^{5}/_{32}$ inch metallic lead. The ratio of lead equivalent thickness to the thickness of barium wall is in the first case 0.083 and in the second 0.078, apparently constant for the two voltages.

On the basis of Mutscheller's estimates of the tolerance dose and his equations for calculating adequate protection, the author presents calculations for certain assumed cases. In an extreme case a roentgenographic room would require $^{5}/_{64}$ of an inch of lead or $^{15}/_{16}$ of an inch of barium plaster to protect the operator adequately, while a treatment room under similar conditions of heavy use would require $^{13}/_{64}$ inch of lead or $2^{1}/_{2}$ inches of barium plaster. For average conditions of roentgenographic traffic about $^{1}/_{32}$ of an inch of lead would be required or $^{3}/_{8}$ inch plaster, but since this thickness of plaster gives nonhomogeneous protection $^{3}/_{4}$ inch thickness should be the minimum of plaster used in any case; for the average treatment room approximately $^{1}/_{8}$ inch lead protection is required or $1^{3}/_{4}$ inch barium plaster.

Berg, Benjamin N., and Jobling, James W. The effect of division and transplantation of the common duct upon gall-bladder function. *Proc. Soc. Exper. Biol. & Med.*, February, 1927, xxiv, 434–435.

The authors have sought to eliminate the action of the sphincter of Oddi to test its control of gall-bladder activity by completely dividing the common duct proximal to the sphincter and implanting the stump into another part of the duodenum. The effect of this procedure upon the action of the gall-bladder was determined by means of cholecystograms. The experiment was performed upon two dogs. Six weeks and eight weeks respectively after operation cholecystograms were obtained in the following manner: 0.12 gm. sodium tetraiodophenolphthalein per kilo body weight was injected intravenously; eighteen hours after the injection of the dye the first roentgenogram was taken. Then the dogs were fed with the yolks of three eggs in 200 c.c. of cream and films were taken at intervals of one, three, six and twenty-four hours after the meal.

In both dogs the shadow was normal in size and density at the 18th hour observation. Following the meal in one dog there was progressive shrinkage and increased density of the shadow with complete disappearance at the 24-hour period. In the other dog there was only a slight decrease in the size of the shadow but there was a definite diminution in density, most marked after six hours; after twenty-four hours the shadow was still present. These findings are within the normal variations for dogs. From this it would appear that normal cholecystograms may be obtained in dogs after division and transplantation of the common duct. This excludes a reciprocal relationship between the sphincter of Oddi and the gall-bladder.

Brandess, Theo. Measurement and adjusting device for the roentgen irradiation of carcinoma of the neck of the uterus. *Strahlentherapie*, 1926, xxii, 569–577.

The author claims that the recent description by Palugyay of a special device for precise adjustment of the roentgen tube for the treatment of carcinoma of the neck of the uterus by the Wintz method is essentially a copy of the author's roentgen "circle" for the localization of the portio vaginalis, which was briefly de-

scribed in 1923. The author presents in this paper the details of operation which have been furnished to purchasers of the instrument.

BREITLÄNDER, KURT, and JANSSEN, KARL. Comparative iontometric roentgen-ray measurements with the iontoquantimeter of Wintz and the Martius ionimeter, also a contribution to standard dosimetry in R-units. *Strahlentherapie*, 1926, xxii, 263–279.

The reproduction of a radiation by maintaining a constant scale reading at the switch board is not readily attainable under the usual conditions of current fluctuation in the main supply line. Variations in voltage of a 220 volt supply were found to be as great as ±10.5 per cent. This would correspond in the Symmetrie apparatus to a maximum variation of 4.3 per cent in the reading of the hardness meter, and in the Intensiv-Reform apparatus to a maximum variation of 11.8 per cent in the kilovolt reading referred to the mean position of the pointer. In the Symmetrie apparatus, fluctuations of 4 scale divisions in the hardness meter corresponded to differences of 10 kilovolts in the secondary; in other words, with a maximum of ±4 scale divisions there was a fluctuation of 6.2 per cent in the secondary at 160 kv. and 5.5 per cent at 182 kv. In the Neo-Intensiv-Reform apparatus (without condensers) the variations in tube voltage were ±3.5 per cent at 192 kv., with a maximum fluctuation of ±5 per cent. Consequently in the operation of the authors' setup employing tube voltages of 192 to 182 kv. the expected fluctuation may be from ±3.5 per cent to 5.5 per cent. In the most extreme case this would correspond to a variation in depth intensity of ±1 per cent; or in absolute values the change would be about ±5 per cent of the relative depth intensity.

The iontoquantimeter indicates relatively higher values of percentage depth intensity than does the Martius ionimeter, which is apparently due to the difference in size, position on the surface, and composition of the ionization chambers. The calibration of the iontoquantimeter in terms of the standardized ionimeter showed with a radiation of 192 kv., 4 ma., 1 mm. Zn plus 1 mm. Al, an ionization of 5.05 R over the entire scale; with a radiation of 182 kv., 4 ma., 0.5 mm. Zn plus 1 mm. Al, the ionization was 3.73 R. The measurements in both cases were taken with a portal of 6 × 8 cm., the chamber being free.

The computation of the biological skin erythema dose in R units of the primary energy gave a value of 500 R. This value should be maintained because it yields a sufficiently powerful skin reaction. All the treatment times with corresponding focal skin distances employed by the authors were corrected on the basis of a primary energy output of 500 R without regard to variations caused by scattering due to change in field size.

Measurements of the scattering expressed in per cent of the primary energy were found to be considerably lower (the maximum 41 per cent) than those reported by Martius and Grebe.

BURROWS, MONTROSE T., JORSTAD, L. H., and ERNST, EDWIN C. The effect of *x*-rays on the vitamin needs of the organism and cancer. *Radiology*, October, 1926, vii, 279–291.

The authors have found that repeated small doses of roentgen rays increase the length of life of animals fed on a diet deficient in vitamine B, while they have little effect on animals fed on a diet deficient in vitamine A. The dose given was 13 e units (10 ma-min.) twice a week at 215 kv. peak, 80 cm. focal skin distance, 0.5 mm. copper. Another similar group of animals were treated with ultraviolet rays and their lives were prolonged to the same degree.

It appears possible from the above observations to explain the intestinal disturbances and rise in temperature effected by roentgenization. Many previous authors have noted the stimulative effects of vitamine B. The present authors have found that many of the changes in the tissues and the fever caused by infection are to be related directly to the excess production of this vitamine by bacteria. It is concluded, therefore, that the whole effect of roentgen rays may be resolved to these same terms. Whether ultraviolet light has a different action is not known.

DEMEL, RUDOLF. Animal experiments on the roentgen irradiation of the cerebrum. *Strahlentherapie*, 1926, xxii, 333–336.

Very young puppies four days old were employed in the author's experiments. The cerebral portion of the skull was irradiated in four sittings, with the face and remainder of the body carefully protected. At each sitting, which was undertaken at four day intervals, 25 skin erythema doses were filtered with 3 mm. Al to deliver ⅔ of a "skin stimulative dose." Eight weeks have passed since the last exposure and the following effects on growth have been noted: The irradiated animal is free from epileptiform attacks such as Brunner found. It would therefore appear that such attacks are not due primarily to roentgen irradiation but apparently to constitutional factors or specific breeds. The irradiated animal shows a pronounced growth disturbance of a general nature without as yet revealing roentgenologi-

cally any alterations in bone structure. The only thing the roentgenogram shows is a somewhat more delicate structure of the skeleton and various bones are somewhat shorter than those in the control animal.

The irradiated animal shows a disturbance in gait resembling a staggering, atactic walk. In running, the animal crosses over its extremities, is uncertain and threatens to topple over at every opportunity. These disturbances in gait are probably due to organic injury in the brain and recall the motor disturbances observed in humans during the course of congenital hydrocephalus.

There were also observed in the irradiated animal changes in the fundus oculi which appeared six weeks after the last irradiation and were characterized by an ophthalmologist as a neuritic atrophy. This finding seems to confirm the possibility that a hydrocephalus is responsible for the changes. These observations on the growing brain were confirmed in 11 other dogs of different litters, although the symptoms did not occur to the same degree.

The brain and fundus oculi were subjected to histological study. Macroscopic observation of the brain showed that the phylogenetically older portions of the cerebrum (such as the hippocampus) appear to be more resistant to the roentgen rays than the phylogenetically younger portions. Histologically there was a reduction of the pyramidal areas and the corpus restiforme in the medulla oblongata, a narrowing of the cerebral peduncle, and a diminution in fibers in the region of the aqueduct. Sections through the optic thalamus disclosed a hemiatrophy of the right thalamus, a hydrocephalus of medium degree on the right, but the basal ganglia showed no atrophy. The retina of the irradiated animal showed apparently normal structure only at isolated spots in the vicinity of the papilla. Along the periphery of the retina, there was found complete degeneration of the external layers with rosette formation, and in certain areas the cornea had disappeared entirely except for a few glia fibers.

Flinn, Frederick B. Radioactive material an industrial hazard? *J. Am. M. Ass.*, Dec. 18, 1926, lxxxvii, 2078–2081.

During the past four years there have been 5 deaths among former employees of a company engaged in painting the dials of instruments with luminous paint. They had a necrosis of the jaw which was claimed to differ from phosphorus poisoning, ordinary necrosis or typical osteomyelitis only in the number of areas involved and their isolation from one another. It is pointed out that the above cases were complicated by syphilis, joint trouble and Vincent's angina, and that the pathological picture was not that of the necrosis known to be caused by radium and roentgen-ray treatment.

The author examined a number of workers at the plant and inspected the process. The luminous paint, depending on the grade, contains from 0.7 mg. to 4 mg. per 100 gm. of zinc sulphide. This material is mixed with an adhesive compound in a small porcelain crucible by the worker. The exposed portions of the body and the clothes of the workers were quite luminescent in a dark room after a day's work. The paint itself could be easily removed from the person with soap and water. Previous observers have claimed that the habit of the workers of pointing the tips of their brushes between the lips is a possibly dangerous procedure explaining the deaths above noted. This idea is not supported by the author who believes that the quantities of radioactive substance transferred to the mouth are altogether too slight, and moreover the use of the tooth brush among the employees is quite general. Another point made by the author and supported by animal experiments is that the radioactive material contained in the paint is excreted to the extent of 98 per cent within a few days after exposure. In addition the luminous material was painted daily for a period of six months on the gums of a number of guinea pigs and goats. During this time no irritation of the gums or mouth in any of the experimental animals was detected. A roentgen-ray examination showed no bone changes, although such changes could hardly be expected to occur in six months and more prolonged observations are necessary to establish this point. It is pointed out that no erythematous reactions were noted amongst the employees who were continuously exposed to accidental spatter of the paint. This was also checked in the laboratory on animals and humans.

The author has examined approximately two-thirds of the employees at present working at dial painting in this country, as regards their blood picture. The hemoglobin was normal in each case, likewise the pulse and blood pressure. A comparison of the blood counts amongst these individuals with those taken on Y.W.C.A. girls does not indicate in any way that the workers engaged in painting dials have been exposed to radioactive material. All electroscopic tests to ascertain the presence of radioactive substances in the bodies of the painters of luminous dials were negative. The conclusion is that there is no justification for assuming that an industrial hazard exists in the painting of luminous dials. The deaths mentioned in the

beginning were from some cause that cannot be determined at the present time.

GAERTNER, OTTO. Intensity measurement of roentgen rays by the ionization method. *Strahlentherapie*, 1926, xxii, 379–416.

The ionization method is reproducible and data are presented supporting this claim. A reproducible value is the expression $\frac{I}{V}$, the ionization current per cubic centimeter of irradiated air under normal conditions, when the kinetic energy of the primary electrons is completely utilized in ionizing the air, and the interior of the ionization chamber emits no primary electrons. The method of determination is simple and the maximum error in the determination of $\frac{I}{V}$ is only 0.1 per cent. Contributory errors may affect the absolute determination of $\frac{I}{V}$ to a maximum of 3.4 per cent, average 2.0 per cent. Greater precision is attainable but does not appear to be necessary so long as the absolute measurement is not more refined.

The average path of electrons produced in air by roentgen rays is considerably smaller than that predicted by the Einstein equation, if only photoelectrons are produced. For this reason it is not necessary to employ ionization chambers with the enormous dimensions of about one meter diameter for the purpose of utilizing with approximate completeness the ionization produced by the kinetic energy of the primary electrons.

GRAHAM, EVARTS A., COLE, WARREN H., COPHER, G. H., and KODAMA, S. Some new phases of the physiology of the biliary tract. *Ann. Surg.*, September, 1926, lxxxiv, 343–351.

The hypothesis of Meltzer concerning the existence of a contrary innervation between the gall-bladder and the so-called sphincter of Oddi has little evidence to support it. The opening and closing of the duodenal end of the common duct depends almost entirely upon tonus of the duodenum, and it is not necessary to assume a separate sphincter to control this mechanism.

The spurting of bile through the ampulla of Vater is due largely to the milking action of duodenal peristaltic waves upon the common duct which passes obliquely through the duodenal wall. The emptying of the gall-bladder is chiefly a passive phenomenon due to factors such as the elastic recoil of a distensible viscus and the gradual washing out of its contents by the ingress of fresh bile from the liver. Increased intra-abdominal pressure is also a factor of some importance. The gall-bladder fails to contract when any of the experimental methods are tried which are known to induce violent contraction of either the urinary bladder or intestine. Muscular contraction of its wall must therefore play an insignificant rôle in the emptying of the gall-bladder. Those substances which are known to induce emptying of the gall-bladder probably have this property by virtue of their ability to cause duodenal peristalsis. Oleic acid seems to be the most potent in this respect.

Cholecystography is a test of the only functions known to be possessed by the gall-bladder. If the organ has been shown to be functioning normally, it almost certainly is not causing symptoms, even if at operation old evidence of disease is found, such as adhesions and scarring. Accuracy in interpreting normality, however, demands great care and experience in performing the test. The intravenous method of administration gives much more accurate results than the oral.

The authors have found that the isomeric compound of tetraiodophenolphthalein, namely, phenoltetraiodophthalein gives equally good shadows in doses only about two-thirds as large as those necessary when the former compound is used. Moreover, in a series of 103 patients injected with this substance there have been no severe reactions at all. This new substance possesses the additional advantage of coloring the serum sufficiently to make it of use as a test of hepatic function in a manner similar to the Rosenthal test. The authors now use phenoltetraiodophthalein exclusively in their work.

GRAHAM, EVARTS A. New developments in our knowledge of the gall bladder. *Am. J. M. Sc.*, November, 1926, clxxii, 625–643.

We are now perhaps just at the beginning of a rational conception of how inflammation of the gall-bladder begins, of how it produces its symptoms and its effects. In solving these questions the pathologists have given scant help. Hepatitis is a constant accompaniment of cholecystitis. In other words, inflammation of the gall-bladder cannot be considered alone but always as a part of a more extensive condition. In the majority of cases, perhaps, cholecystitis is produced by a direct extension of inflammation from a liver already involved to the wall of the gall-bladder. In view of the extreme difficulty encountered in the experimental production of cholecystitis merely by the introduction of bacteria into the lumen of the gall-bladder and also in view of the fact

that in most cases of cholecystitis in man the inflammation is seen to be most marked at the periphery and less marked in the mucosa it seems reasonable to conclude that cases due to contact infection of the mucosa must be relatively few in number.

It is probable that the cases of interstitial pancreatitis which the author obtained following experimental hepatitis and cholecystitis were not due to a lymphatic spread but might have been due to a hematogenous infection.

Diagnosis of typical cases of advanced biliary disease by the well-known clinical signs has been easy, but it is becoming more and more evident that the atypical and the early cases present such vague clinical evidence that many of them will be missed unless other diagnostic resources are utilized. The procedure of Lyon has only an inferential value. Moreover, there is good evidence that the theory upon which the procedure is based (Meltzer's idea of a reciprocal innervation between the gall-bladder and the sphincter of Oddi) is erroneous. Equally disappointing also has been the use of tests to indicate a disturbed liver function as a means of diagnosing cholecystitis. The development of the cholecystographic method of diagnosis is outlined and a general discussion is given of the various factors that enter into the successful application of the technique.

The chief points in making a diagnosis of cholecystic disease from the cholecystogram are (1) failure to obtain a shadow when the technique has been properly carried out; (2) filling defects; (3) irregularities of contour, denoting adhesions, diverticula, etc.; (4) variations from the normal in density of shadow, in the time of appearance and disappearance of the shadow. These last criteria are more difficult points to interpret than the former and they constitute most of the 4 to 10 per cent of failures in diagnosis encountered by various observers at the present time. Up to March, 1926, the method has been employed in 900 cases and of this number 109 had their gall-bladders removed, all of which were subjected to microscopic examination. In only 3 of these cases was the roentgen-ray diagnosis not confirmed. In the last year and a half the contrast medium employed has been almost exclusively the sodium salt of tetraiodophenolphthalein. Cholecystography is a more accurate method of diagnosing cholecystic disease than palpation and inspection of the organ at operation. Because it is a functional test of the gall-bladder it discloses abnormality in very early and mild cases of cholecystitis, perhaps even before structural pathological changes are visible.

Hartman, F. W., Bolliger, Adolph, and Doub, H. P. Experimental nephritis produced by irradiation. *Am. J. M. Sc.*, October, 1926, clxxii, 487–500.

Renal epithelium is readily damaged by high voltage roentgen rays applied through the abdominal wall, with comparatively small changes in other organs. In young animals, particularly, the kidney changes are easily produced without causing the hair to drop out. In proportion to the epithelial damage, an increase in interstitial tissue takes place which replaces most of the tubules and destroys those remaining. The blood vessels from renal artery to small capillaries show thickening of their walls and many undergo complete endarteritis. The epithelial damage gives an opportunity for study of the acute and subacute tubular type of nephritis, while the terminal lesion is a combined type of interstitial and vascular nephritis of extreme grade. The glomeruli are relatively well preserved.

Experiments which were carried out on dogs permitted satisfactory studies of function throughout the course of the disease which are to be detailed in a forthcoming communication. The changes which were found to occur consisted of the presence of albumin and casts during the initial stage, marked polyuria with low specific gravity in the subacute stage and gradual depression of dye excretion with marked nitrogen retention in the final stages. Constitutional changes consisted of hypertension and macular changes. The terminal periods were characterized by acidosis, vomiting, convulsions, coma, oliguria and anuria.

The roentgen rays were applied over an area from 10 to 15 cm. square, with the costovertebral angle as the approximate center. The rays were applied for from 15 to 60 minutes, 200 kv., 30 ma., 1 mm. Cu plus 1 mm. Al, 50 cm. skin distance. Of the 26 dogs studied in this series 8 died acutely within five days after exposure. Eighteen have been followed from one to thirteen months and 14 of these have come to autopsy. Not a single animal has failed to show kidney damage both functionally and histologically.

Hartman, F. W., Bolliger, Adolph, and Doub, H. P. Functional studies throughout the course of roentgen-ray nephritis in dogs. *J. Am. M. Ass.*, Jan. 15, 1927, lxxxviii, 139–145.

Observations were made on 26 animals for periods ranging from four days to thirteen months. The pathologic changes produced by the roentgen rays were found to involve all the renal structures, and in the order of severity are tubular, interstitial, vascular and glomer-

ular. The composite picture produced satisfies the requirements of a chronic nephritis, simulating the disease occurring in man, since hypertension, cardiac hypertrophy, macular changes, acidosis, convulsions and coma were observed. In those animals living two months or more death was usually due to renal insufficiency. The authors sought to determine the functional changes in this renal lesion of known etiology, of relatively uniform pathologic anatomy and which for the most part is confined to the kidney or secondary to the kidney insufficiency. The length and sharpness of the acute, subacute and chronic stages of roentgen-ray nephritis in dogs depend on size of the dose of roentgen rays administered.

No single functional test thus far developed has been found reliable as an index of the extent of kidney injury throughout the course of the progressive lesion. The acute nephritis produced by roentgen rays is comparable functionally with acute clinical nephritis or that produced by heavy metals only in so far as these conditions produce albumin and casts in the urine. Nitrogen retention does not occur except as the animal becomes moribund after a lethal irradiation, and the urea ratio is normal. Late in the acute stage of the disease the urine may be free from albumin and casts while all other tests indicate severe kidney insufficiency.

Hilsnitz, Oskar. Early demonstration of histological changes of the skin after roentgen irradiation. *Strahlentherapie*, 1926, xxii, 525–537.

A recent statement by Bierich claims that immediately after a brief roentgen irradiation there occurs an increased amount of elastic fibers in the skin of the mouse. The author repeated these experiments without being able to confirm Bierich's observations. White mice were used, and a strip 3 cm. long and 1 cm. wide on the back was irradiated. Small sections of the skin were removed for histological study immediately and twenty-four hours after irradiation, sections of normal skin being excised at the same time for controls. The sections were stained with Weigert's elastic tissue stain, with hemotoxylin-eosin and by Mallory's method. The author gives detailed descriptions of the anatomy of the normal and irradiated skins and cites in detail the various protocols. Not only was it impossible to confirm the definite claims of Bierich but the author also failed to note any differences in the intensity of staining of the various skin elements. In no case did the collagenous connective tissue show a greater affinity for Weigert's elastic tissue stain.

Hirsch, I. Seth. A new type of fluorescent screen. *Radiology*, November, 1926, vii, 422–425.

A fluorescent screen has been devised which retains the image for a prolonged period. The screen is made with a fluorescent emulsion which may be spread on any surface permeable to roentgen rays. The nature of this emulsion is not disclosed. A special container for the screen is described in detail. This screen may also be employed in the "operating" bonnet fluoroscope; in this case the new screen replaces the usual fluoroscopic screen and may be swung out of line of vision when necessary.

Irle, Friedrich, and Bergerhoff, Walther. Automatic electrical protection against confusing or forgetting the ray filter. *Strahlentherapie*, 1926, xxii, 562–568.

The usual optical and acoustic warnings are unsatisfactory for the purpose of calling attention to the absence of a filter in a roentgen therapy apparatus. As a quick index that the wrong filter has not been used the device proposed by Heitz is very useful but does not offer absolute protection against injuries if the error happens to be discovered too late. Automatic devices which cut off the current supply are fundamentally the most desirable. A device suitable for practical purposes should answer the following requirements: (1) Cut off the primary or secondary current when the filter is omitted; (2) cut off the primary or secondary current if the filters are mixed; (3) automatic operation of the device without warning signs; (4) testing of the filtration at the switch board; (5) simplicity of construction without requiring additional apparatus (such as relays, magnets, etc.) which might fail to function.

The device constructed by the authors is claimed to fulfill these requirements satisfactorily and details of the installation are presented in drawings and illustrations. The filter frame makes a different contact with each of the various filters employed and the wires are led to the switch board where only the appropriate contact permits the closure of the circuit operating the roentgen tube. The original must be consulted for details.

Kämmerer, H., and Weisbecker, H., The sensitizing action of porphyrin, particularly putrefaction-porphyrin, to light and roentgen rays. *Arch. exp. Path. Pharm.*, 1926, cxi, 263–280.

Porphyrin from urine and feces sensitizes paramecia only slightly, and erythrocytes very definitely to light rays; and when tested on white mice, the effect is intense. Putrefaction-

porphyrin is the most active sensitizer. Roentgen rays alone are harmful to red cells and the damage intensifies the toxicity of pigments in the dark. Roentgen rays if sufficiently intense will injure or kill white mice, but no intensifying effect was noted after porphyrin injections. While it cannot be asserted that sensitization to roentgen rays cannot be produced by fluorescent dyes, such an effect seems highly improbable. Eosin and porphyrin induce no sensitization to roentgen rays.

KRISER, ARTUR. On the technique of roentgen treatment of uterus carcinoma. *Strahlentherapie*, 1926, xxii, 377–378.

Walther Haupt recently reported a device for adjusting the cone of roentgen rays, and the author calls attention to the fact that the same idea and an instrument constructed on the same principles was reported in 1923 by Kriser under the title of "Skull Quadrant, a Device for Irradiating the Hypophysis and other Intracranial Structures." Although superficially the applications appear different the principles are identical. The author reports that Haupt in explanation states that postwar disarrangements prevented him from making an adequate search of the literature.

LAPATSANIS, P. The general effect of roentgen rays on the human organism. *Strahlentherapie*, 1926, xxii, 484–502.

Studies were made on a series of cases of carcinoma, myoma, climateric hemorrhage, adnexal tuberculosis and gynecological inflammations treated with roentgen doses varying from 74 e to 16 e, depending on the requirements of the individual case. The factors studied were the changes in blood sugar, clotting, erythrocyte sedimentability, differential count and pH of the urine. The treatments were given at 180 to 200 kv., 2.2 and 3.5 ma., through 1 mm. Cu plus 1 mm. Al. In all cases there was a more or less distinct drop in the blood sugar after an exposure of one hour, the reduced blood sugar continuing for some time. The minimum occurred within the first two hours and the value then returned to normal in twenty-four to forty-eight hours. In a few cases the compensatory return was absent. This was especially evident in the cases of carcinoma. The effect is probably due to an action upon the vegetative nervous system, direct or indirect. Experiments on rabbits receiving 50 e, which is equal to 30 per cent of the skin erythema dose, always resulted in an increase in the blood sugar.

Blood drawn from the arm vein twenty-four hours after irradiation was found in cases of carcinoma to begin clotting sooner than before irradiation. The time consumed from beginning of clotting to completion remained constant, but the onset was accelerated. More than half of the cases of menorrhagia and myoma also showed this acceleration. The effect on the sedimentability of the erythrocytes was variable. In some cases there was no change, while in others the change was in one direction or the other.

The effect of the roentgen rays on the white blood cell picture was in all cases very distinct. Twenty-four hours after the irradiation the relative lymphocyte count was distinctly lowered and in a few cases resulted in a pronounced lymphopenia. The polymorphonuclear leucocytes showed a corresponding upward curve. The change in the blood picture appeared to be directly proportional to the intensity of radiation applied.

The pH of the urine was determined colorimetrically on catheterized specimens taken every two hours. In general, the effect of irradiation produced during the period of treatment hardly any change in the pH curve of the urine. In some cases, the original value of pH 5.5 to 5.6 shifted in an hour to about 5.7 to 6.0 regardless of size of dose. Twenty-four hours after irradiation while the patients were still under the effect of roentgen sickness and were unable to take food, the average pH value lay between 5.5 and 6.0.

LEVY-DORN, M., and BURGHEIM, F. The effect of roentgen rays on the cholesterin content of the blood in the healthy and diseased body. *Strahlentherapie*, 1926, xxii, 538–549.

The changes in blood cholesterin after irradiation can be determined only in fairly large omnivora (like the dog). It was found that after a preliminary drop (very distinct after three hours) the curve of cholesterin assumes an irregular course and returns to the normal condition in several weeks. The experiments show that roentgen sickness appears to be associated with a pronounced deficiency in blood cholesterin.

In malignant tumors there was found, in contrast to other diseases which thus far have shown a cholesterin decrease, an increase in cholesterin following irradiation, and this fact may be employed for diagnostic purposes. It is urged that this observation be checked by other observers at the earliest possible moment in order to make available this new diagnostic procedure if corroborated. In cases of carcinoma the cholesterin content of 1 c.c. of blood was less than in 1 c.c. of serum, while in other diseases this relation was found to be reversed. Perhaps this fact may also find a diagnostic application.

MALLET, L., and COLIEZ, R. Studies on the distribution of radiant energy in radium therapy. Direct measurement of gamma radiation. *Strahlentherapie*, 1926, xxii, 417–436.

There is a need for the development of a method for measuring gamma rays and the establishment of a unit of radiation similar to that in roentgen therapy based on ionization. The authors believe that measurement of the ionization currents by means of amplifying devices are unsuitable, inaccurate and subject to new sources of error. The ionomicrometer devised by Mallet appears to satisfy requirements. It consists of a very small ionization chamber of 1.5 c.c. which also contains the electrometer, a very small aluminum leaf, the movements of which are observed through a microscope with a graduated ocular. The elimination of the discharge conductor is the most important characteristic of the apparatus which, as a result, is not subject to premature discharge from parasitic ionization. The ionization chamber and microscope may be introduced into the water phantom and the radium tubes or applicators may be shifted with respect to the fixed ionization chamber. The instrument can be calibrated with a definite quantity of radium.

Proust and Mallet have proposed the decigram-hour as the unit of dose and have designated it by D in memory of the famous radium therapist Dominici. This dose represents the gamma energy output of a radium tube 2 cm. long containing 10 mg. radium element and filtered through 1 mm. platinum when kept at a distance of 2 cm. from the ionization chamber for 10 hours, i.e., 100 mg-hr.

Assuming a single tube, an applicator with several tubes or specially shaped apparatus, one may take measurements at various distances to obtain the variation in intensity; and isodose curves can be easily constructed from these measurements. In the case of specially shaped applicators one can determine in advance the length of treatment necessary to produce a certain reaction upon the skin surface.

According to the authors' experience an erythema dose corresponds to about 17 D units and radiodermatitis results from 32 D. In practice one should avoid exceeding these values. Experience seems to show that heavily filtered radium (a minimum of 1 mm. platinum) is unnecessary to deliver a dose corresponding to radiodermatitis upon neoplastic cells. It appears that about 60 per cent of this dose is sufficient.

The authors have determined the distribution of energy in all directions emitted by the customary applicators in practice. Such isodose curves were determined for a tube 2 cm. long containing 10 mg. radium element and filtered through 2 mm. platinum. These curves were transferred to a sagittal section of the pelvis to demonstrate the zones of influence from insertion of the tube in the neck of the uterus. Corresponding curves for the transverse section of the pelvis are shown. Similar data for two radium tubes are presented.

Brief descriptions are given of curie deep therapy of the various portions of the body with measurements of the depth dose where radiation is administered from the surface.

MOTTRAM, J. C. Experiments on the radiation of tumours. *Brit. M. J.*, Feb. 12, 1927, i, 275–277.

Tumors left four to five days in the animal after irradiation and then removed and grafted into other animals succumb more easily than when removed immediately after exposure. This effect is associated with an interference with the blood supply which occurs four to five days after exposure. These results suggest the hypothesis that the varying sensibility to radiation of tumors and the difference in sensibility between normal tissues and tumors are associated with the variations in blood supply on which the radiation has a special action apart from its direct action on cells.

The above conclusions are based on experiments made with the transplantable mouse sarcoma No. 180 which grows in almost 100 per cent of transplants. Mice were inoculated in the flank with small pieces of the tumor, approximately 1 cu. mm. When these had grown to approximately 4 × 4 mm. superficial area they were irradiated with 20 mg. radium element, area 15 × 15 mm., screen 0.35 mm. silver. The exposures were for 10, 15 and 20 minutes.

REED, C. I. Development of knowledge of radiant energy as applied to medical uses. *Radiology*, October, 1926, vii, 292–296.

A brief chronological account is presented of the subject, including an elementary account of the physical basis of light biology and of photochemical reactions.

STENSTRÖM, WILHELM, and REINHARD, MELVIN. Some measurements of the transparency of skin to light. *Acta radiol.*, December 15, 1926, v, 553–560.

The percentage of light rays striking the skin (taken from young mice) at a normal angle of incidence and going straight through has been measured for wave lengths between

700 and 415$\mu\mu$ and traced down to 315$\mu\mu$ by means of a quartz spectrograph and a sector photometer. The measurements were also made of the percentage of light rays under the above conditions which scattered through within an angle of 40°. In this case, mouse skin 0.5 mm. thick and human skin 2.5 mm. thick were employed. The total amount thus penetrating the skin was found to be 100 times greater than the amount which goes straight through the skin.

The relation of the total amount of light penetrating 0.5 mm. mouse skin and 2.5 mm. human skin is about 10 to 1. For the more penetrating rays toward the red end of the spectrum the ratio is smaller than 10 to 1, and for the less penetrating ultraviolet rays it is greater than 10 to 1.

Stewart, Harold J. A technique for measuring *x*-ray photographs of the cardiac areas of dogs. *J. Clin. Investigation*, Feb. 20, 1927, iii, 475–482.

It is often important in the study of problems of the circulation to be able to determine what effect an experimental procedure has on the size of the heart of the animal under investigation. For this reason the author has developed a technique for obtaining roentgen photographs of the dog's heart so that successive records are comparable as to the size of the shadow cast by the heart. The method for obtaining the area of the heart shadow is the one commonly in use as devised by Levy.

The variations found in the size of the heart in roentgenograms made on the same day were less than 3 per cent. A variation greater than 10 per cent was not obtained in normal dogs over a period of eight days, and it is believed that a variation greater than this can be interpreted as a real change in the size of the heart.

Taft, Robert B. Charging device for electroscope. *Radiology*, December, 1926, vii, 513–514.

The author employs a simple and inexpensive arrangement composed of a Ford spark coil operated on two or three dry cells. This gives a high voltage, direct current, the positive pole of which is connected to a fine needle point placed about three-quarters of an inch from the post that supports the leaf of the electroscope. This distance is much greater than the actual sparking distance of the coil but allows a gentle brush discharge to take place, slowly lifting the leaf to the desired potential. By being lifted slowly (2 or 3 sec.) the leaf is spared any sudden shock which might result in damage. No switching device is needed except a push button in the primary circuit. The wiring diagram is given.

Van Allen, C. M., Fox, R. A., and Colle, H. G. Cough as a factor in chronicity of experimental lung abscess. *Proc. Soc. Exper. Biol. & Med.*, March, 1927, xxiv, 485–489.

A preliminary report is given comparing the course of lung abscess in dogs as it occurred without cough with that of cases in which cough was stimulated. In each of 16 dogs, a 1 cm. segment of femoral vein was resected and used as a container for a lead pellet and fragment of agar bearing a growth of virulent *Staphylococcus aureus*. This capsule was then introduced into the venous stream and allowed to be carried as an embolus to the lung where it lodged in one of the lower lobes. Roentgen examination of the chest was made at various times after the embolus. Six of the dogs were made to cough from the second week on by one means or another. Roentgen plates on the sixteenth day demonstrated cavitation in 5 of the controls, the other 5 presenting only some induration in the region of the pellet marker. Four of the coughing dogs showed cavities in the lung field all greater than those of the controls, 2 being of very considerable size. The remaining 2 dogs which coughed showed local induration only. At necropsy, after thirty to thirty-five days, it was found that none of the controls showed persistence of the cavities except as containers of the pellets, while all the dogs of the coughing group with cavitation showed persistence of the cavitation to the end of the experiment. These data indicate that in dogs an infected embolus in the lung does not always result in absence with the particular strain of organism used, that the disease is characterized by abscess of cough and rapid healing and that when the factor of cough is superposed, the cavities which form may be much larger and persist much longer.

Wynen, Walter, Hyperemia as secondary ray sensitizer in roentgen irradiation. *Strahlentherapie*, 1926, xxii, 503–513.

The effects of roentgen rays were observed subsequent to the production of hyperemia in a tissue by (1) diathermy, (2) stasis, (3) sympathectomy. When hyperemia was maintained in the human skin by diathermy for a quarter hour preceding and during roentgen irradiation, there was required 30 to 40 per cent less roentgen energy to produce erythema than in the non-hyperemic skin. The application of equal doses (one skin erythema dose = 500 R) on previously diathermatized and upon normal skin resulted in the first instance in a pronounced edema and a tense infiltration of the skin which under further diathermy increased con-

tinuously for fourteen days and then gradually decreased. The edema is perivascular and caused by increased permeability of the capillary wall. This effect is entirely independent of the temperature and of the high frequency current employed. Indeed the same effects can be produced after hyperemia induced by hot air.

Experiments show that by congesting the tissue to be irradiated a much greater quantity of roentgen rays is absorbed which produces a correspondingly greater degree of injury. This primary intensified effect can be compensated by a continued hyperemization of the normal skin. It is pointed out that despite the great physical, chemical and physiological differences between active and passive hyperemia the above mentioned effect is the same for both types of hyperemia.

The effect of sympathectomy was tried upon animals, and considerably larger doses of roentgen rays were employed. Two limbs of the animal were irradiated, one of the limbs having previously been sympathectomized. The effects found were not very sharp. It was observed that congestion of the limb was associated with milder symptoms of roentgen ulcer and more rapid recovery. It follows therefore that if a generous blood supply tends to prevent permanent roentgen injury then anemia would have the opposite effect. However, this conclusion was tested experimentally on a dog by the excision of large portions of the femoral artery but the result was negative.

ALBERTI, W. The periscope tube. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 941–945.

A description is given of a device for exact focusing and delimitation of small fields to be irradiated and for direct observation during irradiation. This device makes it possible to focus, outline and observe at any time without interrupting irradiation those parts of the body which are not directly visible, either through their anatomical position or because the irradiating mechanism intervenes. The delimitation is accomplished by the use of a tube of sheet lead specially adapted for each case. The field to be exposed is illuminated artificially and is made accessible to the eye by means of the periscopic reflector.

BRAMBELL, F. W., PARKES, A. S., and FIELDING, U. Changes in the ovary of the mouse following exposure to x-rays. Part I. Irradiation at three weeks old. *Proc. Roy. Soc. Lond.*, 1927, ci, Ser. B., 29–56.

The ovaries of 47 female mice exposed to a full sterility dose of roentgen rays at three weeks old are described. Irradiation is followed by the degeneration of all the oocytes. The membrana granulosa and the theca interna, in those cases where it is differentiated, degenerate also. Finally the old follicles are represented only by small cavities containing remnants of zona pellucida. In a few cases the larger follicles become filled with blood and form cysts, or the cells of the theca interna and membrana granulosa grow and, invading the antrum, form a corpus luteum atreticum. These last named bodies persist indefinitely but are shown to have no influence on the estrous cycle.

Simultaneously with these changes the old interfollicular tissue atrophies, and the germinal epithelium proliferates epithelial cords. In the adult animals the ovaries are composed almost entirely of this first proliferation and in some cases it tends to become like luteal tissue. In many cases a second proliferation from the germinal epithelium follows. This consists of small spherical or slightly elongated cords. These cords resemble the so-called spermatic cords described in the ovaries of inbred rabbits and of free-martin cattle by a number of authors. They also resemble structures described as anovular follicles. The cords of the second proliferation appear to have no effect on the estrous cycle.

BRAMBELL, F. W. R., PARKES, A. S., and FIELDING, U. Changes in the ovary of the mouse following exposure to *x*-rays. Part II. Irradiation at or before birth. *Proc. Roy. Soc. Lond.*, 1927, ci, Ser. B. 95–114.

The ovaries of 6 mice irradiated *in utero* and of 30 irradiated at birth are described, and the results confirm those obtained with mice irradiated at the age of three weeks. The degeneration of the oocytes and follicles is followed by two successive proliferations from the germinal epithelium in the form of cords. Some of the degenerating follicles produce cysts or corpora lutea atretica. The latter may persist indefinitely but have no effect on the estrous cycle.

Of the animals irradiated at birth, 24 were allowed to become adult. The cords of the first proliferation constituted the bulk of all the ovaries, and those of the second proliferation were found in only 11 of the cases. Follicles were completely absent in all but one case. These 24 animals are divided into three groups: (1) The cells of the first proliferation are small, shrunken, and vacuolated. The estrous cycles are irregular and in some cases prolonged vaginal cornification occurred. (2) The cells of the first proliferation are large, healthy and glandular in character, and somewhat resemble luteal tissue. The estrous cycles are normal and

regular. (3) The cells of the first proliferation very closely resemble luteal tissue. The estrous cycle was absent or had ceased for at least thirty-six days previous to being killed.

It is concluded that the cells of the first proliferation are mainly responsible for the production of estrin and the regulation of the estrous cycle. The product of estrin appears to stop when the differentiation into luteal-like cells attains a certain degree.

Butts, Donald C. A., Benson, F. C., Jr., and Frank, J. W. The electron in and out of the roentgen tube and the radium atom. *Radiology*, January, 1927, viii, 44–66.

If neoplastic tissue exists in an electropositive state as compared to normal tissue, it might be assumed to have a greater affinity for electrons then would the normal tissue. This attraction of the positive tissue for negative electrons is believed by the authors to be manifested in the fact that the "cancer cell" is more radiosensitive than is the normal cell. However, this affinity of neoplastic tissue for electrons has a capacity to place the cell in a condition of equilibrium. This state of balance is what the authors attempt to attain and maintain.

Chantraine, Heinrich, and Profitlich, Paul. On the hot cathode rectifier tube. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 919–921.

When operating with hard rays it is immaterial so far as the roentgen-ray tube is concerned whether a spark gap rectifier is employed or a hot cathode rectifier tube. The advantages of the latter are noiselessnesss, trifling loss in voltage and absence of harmonic oscillations. It has been found that when working with soft rays in roentgenography only the 22° preceding and after the voltage peak take part. Since the spark gap rectifier cuts out a 60° sector from the half sine curve, and since this portion does not participate in the production of the picture, the result is that by using the spark gap rectifier there occurs 33 per cent less heat load on the tube focus for the same output of radiation. Simple direct current produces for the same heat load on the anticathode at least $2\frac{1}{2}$ times the amount of useful radiation as compared with the present-day hot cathode rectifier tube (Kenotron). The authors regard the present-day Kenotron as belonging to non-roentgenological fields. Such a tube, if it is to find application in roentgenology, should be improved so as to deliver current with a minimum heat load on the anticathode and a maximum of radiation output.

Chantraine, Heinrich. Radiation output of gas and vacuum tubes. *Fortcsbr. a. d. Geb. d. Röntgenstrahlen*, 1926, xxxiv, 922–929.

In order to improve the efficiency of vacuum tubes to the level of gas containing tubes it is necessary to determine the reason for the better radiation output of the latter. If a film is rotated by means of a synchromotor behind a lead screen containing a narrow slit, and there is interposed a filter having the same absorption for the rays as the particular portion of the body roentgenographed, it is possible to determine visually the degree to which the various sectors of the half sine wave participate in the production of the picture. When a spark gap rectifier is employed, it is found that the vacuum tube operated for soft ray roentgenography produces effective radiations only in the sector extending 22° before and after the voltage peak. On the other hand, the gaseous tube produces useful roentgen rays practically throughout the entire cycle in which current flows through the tube. The gaseous tube therefore delivers about twice as much soft roentgen rays as the vacuum tube. It is shown that for soft radiation the breakdown voltage of the gaseous tube is of no consequence. The spark gap rectifier produces harmonic oscillations which are very pronounced at low milliamperages and impede the radiation output very considerably. In the gaseous tubes the harmonic oscillations appear more easily than in the vacuum tube. At high milliamperage these oscillations disappear practically completely. If it is desired to produce a maximum of radiation with a minimum of focus, it is essential not to send through the tube any current which does not assist in the actual production of the roentgen picture; i.e., a direct current must be employed which exhibits no variations in voltage greater than 5 per cent. The gas-free tube operated on direct current will deliver at least twice the quantity of rays that it can yield when operated with the spark gap rectifier.

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